THE UNIVERSITY OF ALBERTA

VERBALIZATION AND SELECTIVE ATTENTION IN DISCRIMINATION SHIFT PROBLEMS

BY

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

EDMONTON, ALBERTA

FALL, 1971

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Verbalization and Selective Attention in Discrimination Shift Problems" submitted by Anne B. Smith in partial fulfilment for the requirements for the degree of Doctor of Philosophy.

ABSTRACT

One hundred and eight grade one subjects were randomly assigned to three tactual discrimination problems (an intradimensional, extradimensional and control shift) and three verbalization treatment groups (spontaneous, assigned and no verbalization). The three shift problems involved mediational transfer of some kind from a training to a shift problem--positive transfer for an intradimensional shift, neutral transfer for a control shift and negative transfer for an extradimensional shift. The verbalization treatments required the subject to overtly verbalize labels (spontaneous or assigned) for stimulus cues in the training task, before the instrumental response was made.

The trials to criterion, percentage, relevant and total observing per trial of the experimental groups were compared. The results indicated that the intradimensional shift was learned most rapidly, the control shift at an intermediate rate and an extradimensional shift most slowly. Immediately after the shift, the relative amount of tactual observing to the relevant dimension was greatest for an intradimensional shift, intermediate for a control shift, and least for an extradimensional shift. Verbalization treatments facilitated the learning of all three shift problems and led to a greater overall tendency to tactually observe both of the stimulus dimensions. It was concluded that attentional mediation was involved in discrimination

learning and that verbalization encouraged such mediation.

ACKNOWLEDGEMENTS

Sincere thanks are extended to those who made possible the development and completion of this study. The intellectual stimulation, encouragement and constructive criticism offered by my supervisor, Dr. R. Barham, was invaluable. The helpful suggestions and guidance, which came from the members of my committee are much appreciated. Additional invaluable advice and consultation came from Dr. T. Maguire, Mr. Brian Haig and Mr. Dennis Hunt. Without the cooperation of the Department of Radio and Television, University of Alberta, the Edmonton Public School Board and the principals and teachers of Norwood, Patricia Heights and Rio Terrace schools, this study would not have been possible. Finally, the most patient support of my husband, John, is gratefully acknowledged.

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CHAPTER I

INTRODUCTION

The present study is an attempt to clarify our understanding of the functioning of mediation within the context of discrimination learning, and to investigate the effects of verbalization upon such mediation.

The nature and role of mediation in learning, including developmental changes in mediation, have been issues of particular interest in psychology since the early nineteen fifties. Mediational processes appear to be involved not only in simple discrimination learning, this being one of the essential functions through which the child makes sense of his environment, but also in more complex types of learning such as the establishment of word meaning, the growth of concepts, and in creative problem-solving--all issues of vital interest to the educator. Mediation theory provides a useful model for investigating such educationally relevant processes.

Briefly, the mediational model assumes that a person makes an implicit response to some external source of stimulation. This in turn produces an internal "response-produced stimulus" which elicits an overt observable response on the part of the subject. These events may be represented thus: S - r - s - R (Kendler & Kendler, 1966). The covert response and associated

stimulus constitute the mediating response. The nature of the intervening process has commonly been left unspecified, but current exploration of discrimination learning has encouraged some theorizing about and investigation of the nature of mediation in such learning.

Among some earlier work on discrimination learning (Kendler, 1963), implicit verbal cues were suggested to be the mediators, but more recently several authors (Turrisi, 1970; Wolff,1967a) have argued that the essential elements of mediation are selective attentional processes.

The debate concerning the functioning of either verbal or selective attentional mediators in discrimination learning, often presented as though one process were exclusive of the other, is addressed in the current investigation. Specifically, the issue of whether or not selective attention is involved in mediational behavior is explored by examining the tactual observing responses of children in a selection of discrimination learning tasks which have been designed to investigate mediational transfer. The tasks employed have come to be known as discrimination shift tasks. Perhaps more importantly, the study investigates the possible influence of different verbalization behaviors both upon performance on transfer tasks and upon the functioning of selective attentional responses.

CHAPTER II

THEORETICAL AND METHODOLOGICAL BACKGROUND

The term "mediation" is defined in this study as:

> . . . a response or series of responses, which intercede between the external stimulus and the overt response to provide stimulation that influences the eventual course of behavior. These responses may be overt, but they are originally presumed to be covert (Kendler, 1963, p. 34).

Jensen (1966) differentiates between people who may be described as mediators and those described as non-mediators. In a non-mediator responses are made more or less directly to the sensory input as it is encoded in the sensory areas of the brain. The mediator, however, is further removed from the sensory input since the sensory stimulation sets off a chain of verbal or other associations and the subject responds to these.

Two criteria of mediation, according to Goss (1961) is that it intervenes between initial stimulation and final response and that it has an effect on the occurrence or strength of the terminal response. According to Gollin and Saravo (1969) the essential attribute of different forms of mediation is to modify the environment to which children respond.

> There is a shift in saliencies, in causal attributions, in the ability to integrate events over time, in the ability to be selectively attentive, and in the ability to shift behavior in the face of changing environmental demands (Gollin & Saravo, 1969, p. 46).

This ability to reorder the significance of environmental events, they claim, is attributable to both the emergence of verbal mediation systems and other types of mediation, such as attentional mediation.

The Role of Language in Mediation

Attempts to explain differences in children's approach and solution to discrimination tasks with age have often suggested that an increasingly important role is played by language during development. Whereas younger children appear to approach discrimination problems in a random fashion, not dissimilar to rats, older children go about a task more thoughtfully, ". . . their behavior appearing to be under the control of stimuli emanating from elsewhere than the external environment" (Fellows, 1968, p. 76). This gradual change in the nature of responding can be argued to be closely connected with the development of verbal mediation, which is defined by Jensen (1966, p. 101) as "talking to oneself in relevant ways when confronted with something to be learned, a problem to be solved, or a concept to be attained".

Luria (1969) sees a link between verbal mediation and the attentional behavior of children. He claims that the act of labelling a stimulus has the immediate effect of distinguishing it from other stimuli in the environment so that the child is more likely to attend to the labelled stimulus. During the course of development the child learns

to point to objects, to note their position in space, but when he uses a specific word to designate an object he has achieved an important tool of self-initiated feedback for the processing of environmental stimuli. Self-initiated feedback of this nature is a mediational process which Luria calls "voluntary attention".

> By 'voluntary attention' we should understand a reflex act, social in origin and mediated in its structure, in the presence of which the subject begins to guide himself by the very changes which he has produced in the environment, and in this way he masters his own behavior (Luria, 1969, p. 149).

Mediational learning, according to Luria (1969), is unstable in preschool children, while in the young school child mediation is controlled by external speech stimuli. However, older children are able to use "inner" mediation where a system of inner speech signals enables the child to cope effectively with discrimination tasks. Hence one could expect experimental treatments of overt verbalization to facilitate mediational transfer tasks (such as discrimination shift tasks which are described in more detail below) and to increase attention to stimulus cues for young school children.

Luria (1961) describes the process by which fresh stimuli evoke orienting reflexes which decline with repeated presentation. The rate of habituation of the orienting reflex, according to Luria, is very easily modified by the influence of verbal labels and verbal

instructions. Stimuli given such signalling property produce virtually inextinguishable orienting responses, and prevent the subject from responding to other extraneous stimulation. The effect of verbalization, in Luria's view, is to allow continued attending without habituation to the verbalized stimuli.

The original source for mediation, according to Luria (1961), is the speech of the adult who helps to label aspects of the child's environment and thereby draws attention to the parts of it which are labelled. Increasingly, however, the child himself takes over this function using his own stock of words to help process the stimuli of the environment.

Vygotsky (1962) claims that word meaning is of fundamental importance in the development of thought. He sees word meanings as "acts of verbal thought". Word meanings allow for the development of concepts which are distinctive from sensation because generalization is involved. When Vygotsky discusses the role of word meaning in behavior it would seem that he is discussing something very similar to what western psychologists might call verbal mediation.

One question which is relevant to the effectiveness of verbal labels as mediators is whether labels are more effective mediators when they are emitted by the child or when they are imposed by another person. While an imposed

label may be more "appropriate" in the sense that it should have the necessary denotative meaning for the referent, it is possible that the child has not learned the denotative meaning of the label, so that the referent is not rendered meaningful by such a label. If, however, the child does have the necessary denotative association for the label, and the assigned label evokes the appropriate mediation which might not have otherwise occurred, it may be expected that assigned labels may facilitate mediational transfer. Conversely there are good reasons for predicting that the child's own spontaneous verbalizations of labels for stimulus cues would be more effective verbal mediators than assigned labels. The child has already built up chains of associations to his own words whereas it is possible that meaning may not be well-established for assigned labels.

The Role of Attention in Mediation

As can be seen from the preceding discussion, it is not necessary to regard verbal and attentional processes as unrelated in mediation. However, a good deal of theoretical interest has been directed to a purely attentional view of the mediational transfer that occurs in discrimination shift problems. The intervening factor between the presentation of the stimulus and the overt response in discrimination learning has been commonly postulated to be selective attentional in nature and the

role of verbal mediation has been minimized.

The problem of defining attention is a complex one. Indeed, accounting for all aspects of attention has been described as a "thirteenth labour of Hercules" (Blum & Adcock, 1968). Accordingly, a detailed exploration of attentional theory has been deemed neither possible nor desirable in this context. On the other hand, the use of "attention" as an explanatory concept, especially in problems of discrimination learning, has so often been uncritical and unrelated to learning theory, that some clarification and definition is needed in a study which involves aspects of attention.

Berlyne (1967, 1971) has suggested that there are two main aspects to attention--the intensive and selective aspects. Intensive attention refers to the general state of alertness of the organism, the manner in which it responds to the stimulus field as a whole. The general level of arousal (psychophysiological responses of the organism) and the orientation reaction seem to be related in particular to the intensive aspects of attention. Selective attention, on the other hand, concerns the distribution of attention among competing stimuli and will tend to determine which elements in the stimulus field will exert a dominating influence over behavior. Observing responses such as eye movements or tactual observing responses (touching) appear to be measurable aspects of

selective attention since they expose the receptors to the stimulus or a certain portion of it. Selective attention may be conceived of as a mediating response which supports certain sensory-inputs. According to Hebb:

> . . . the distinguishing mark of the higher animal is the capacity to hold an excitation for some time before it has its effect on behavior. The mediating response that does the holding is apt to introduce selectivity into the behavior in either or both of two ways, in the form of attention or set (Hebb, 1966, p. 95).

Wyckoff (1952) argued that observing response theory was applicable to discrimination learning. An observing response, according to Wyckoff, is a response which exposes the sense organs to discriminative stimuli. However, Reese and Lipsitt (1970) caution that the attentional response is not the same as the overt observing response. The attentional response is usually regarded as a more central cognitive process (Mandler, 1962). However, the few studies (Rydberg, 1969; White & Plum, 1964) which have involved the measurement of overt observing responses in discrimination learning provide support for the view that selective attention is related to peripheral observing.

Several theoretical models have been constructed which suggest that selective attention is one of the processes occurring in the learning of discriminations (Lovejoy, 1966; Sutherland, 1959; Zeaman & House, 1963). Zeaman and House (1963) regard discrimination learning as a two-stage process. The subject first learns a central

mediating response, attentional in nature, to the relevant stimulus dimension, and then learns an instrumental response by approaching the correct cue of the dimension revealed by the observing response. Zeaman and House constructed a "probability tree", plotting the possible observing and instrumental responses which may occur in a discrimination learning task, assuming a basic one-look model. The actual reinforcement or non-reinforcement of any particular observing or instrumental response is said to affect the future probability of occurrence of all possible observing and instrumental responses in different ways. Using this model, Zeaman and House programmed computers to generate theoretical learning curves for groups of "stat children" whose "behavior" followed the assumptions of the theory. They were able to show that the theoretical curves were a good approximation of the learning curves found with real children.

The Discrimination Shift Paradigm

A good deal of research has been devoted to the question of mediation using variations of an experimental paradigm originally developed by Buss (1953) and Kendler and D'Amato (1955), namely the discrimination shift task. The paradigm has evolved considerably in recent years to overcome various criticisms of the original paradigm (Shepp & Turrisi, 1966; Slamecka, 1967; Wolff, 1967a). An improved paradigm which is called the "total change design"

was devised by Shepp and Eimas (1964). The total change design involves shifting from a training problem to shift problems with different cues in order to prevent the occurrence of instrumental transfer in the design. The paradigm, then, is of relevance to mediational theory because it compares the learning of discrimination problems which differ in the direction of mediational transfer from a training to a shift task.

In the total change design, discrimination shift tasks involve the initial presentation of a series of pairs of stimuli differing along one or more dimensions, one of which is relevant to the solution of the problem. If the subject chooses the correct stimulus he is reinforced in some way and if he chooses the incorrect stimulus he receives no reinforcement. When the subject reaches some predetermined criterion (e.g. 9 out of 10 correct choices) on the initial task he is shifted onto a second problem where the reinforcement contingencies and the correct solution with respect to the relevant dimension are changed. The second problem is usually referred to as the shift problem.

If the subject is presented with an intradimensional shift he is required to solve a discrimination problem involving the same two dimensions as were present on the training problem but with new cues from these dimensions. The same dimension which was rewarded on the training task

remains relevant on the shift problem while the dimension which was not correlated with reinforcement on training remains irrelevant on the shift. The intradimensional shift is thought to involve positive transfer of mediation from the first to the second problem because a mediational chain learned on the first problem can be used in the shift problem to aid solution. The following concrete example illustrates the nature of an intradimensional shift. For the training (preshift) task a subject is presented with alternating pairs of visual stimuli--red circle and blue square, and blue circle and red square--and required to choose "red" (instrumental response) consistently. He is then presented with the transfer (shift) task where two new pairs of visual stimuli are presented in alternation--yellow triangle and green cross, and yellow cross and green triangle. He must now learn to choose "yellow" (see Figure 1). The above example has color as the relevant dimension on training and shift tasks and form as the irrelevant dimension.

An extradimensional shift involves a different relevant dimension on shift from the one relevant in training. The initially relevant dimension is usually retained as the irrelevant dimension (using different cues) on the transfer task. The extradimensional shift is assumed to involve negative transfer of mediational response, since to continue to respond on the shift task in terms of the

mediational response learned in training, slows down the solution of the shift problem. An example of an extra-dimensional shift (see Figure 1) could involve the same training as an intradimensional shift such as to choose "red" on being presented with red circle and blue square, and red square and blue circle. On the transfer task the subject might now be required to choose "triangle" when presented with yellow triangle and green cross, and yellow cross and green triangle. The example of an extradimensional shift described involved color as a relevant dimension and form as an irrelevant dimension on the training task, and form as a relevant dimension and color as the irrelevant dimension on the shift task.

The third shift problem recommended by Shepp and Turrisi (1966) is the control shift, which consists of shifting to a problem in which cues from entirely new dimensions, which have been neither relevant nor irrelevant during training, are introduced. In this type of shift the mediating responses established during training are not relevant but do not impair learning since the mediation does not have any relationship to the new dimensions. The subject again has to learn new mediating responses (as in an extradimensional shift) but no negative transfer is believed to occur because the old mediating response is not related to the irrelevant dimension in a control shift. The purpose of including a control shift is to serve as a

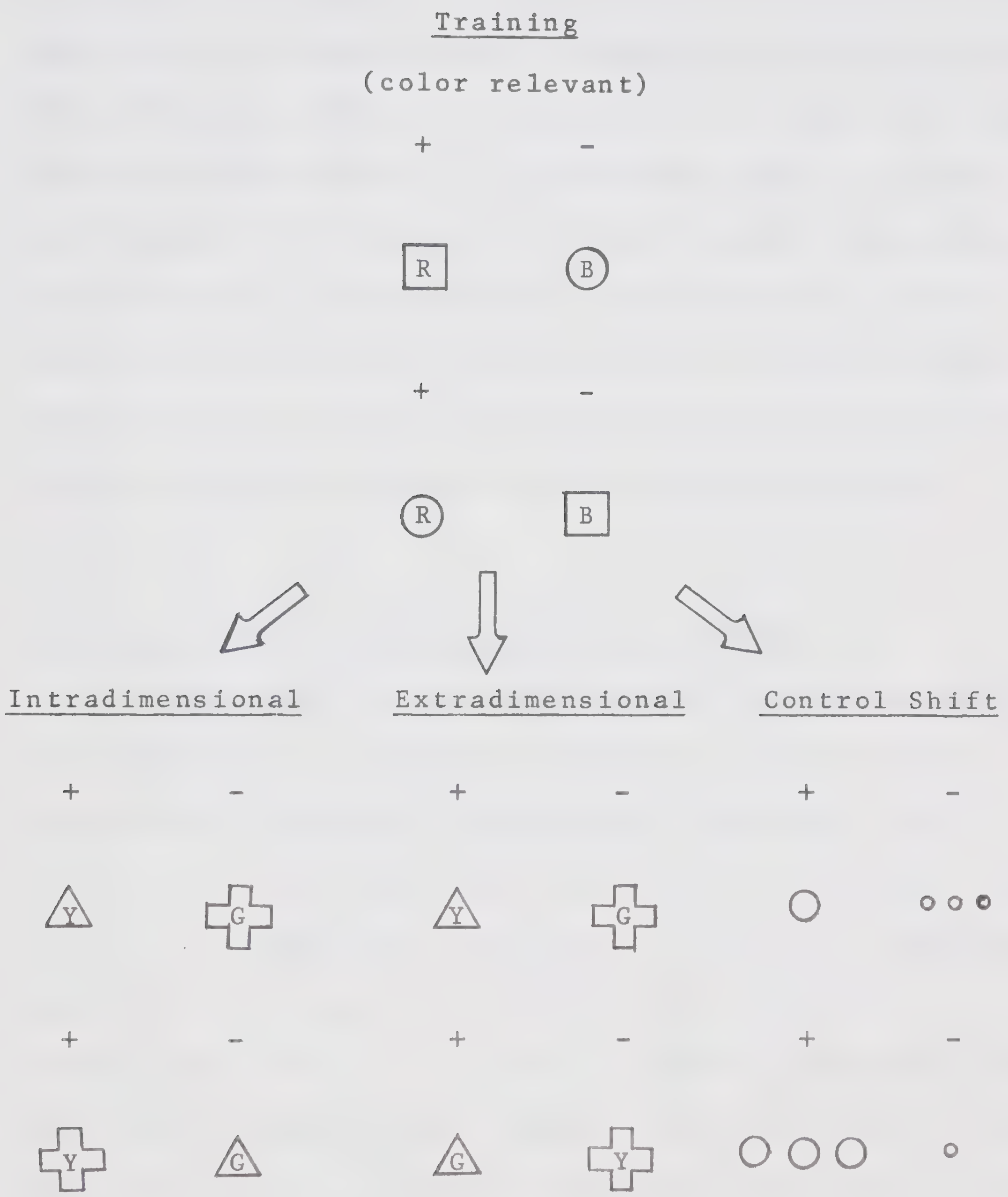


FIGURE 1

EXAMPLES OF AN INTRADIMENSIONAL SHIFT, AN EXTRADIMENSIONAL SHIFT AND A CONTROL SHIFT

control for non-specific transfer such as learning set. An example (see Figure 1) of a control shift would be the learning of the instrumental response of choosing "red" when presented with red circle and blue square, and red square and blue circle on the training task. A shift task might require the subject to choose "large" when presented with one large circle and three small circles, and one small circle and three large circles. In other words the subject learns a color-relevant form-irrelevant problem and is shifted to a size-relevant number-irrelevant problem.

Relation of Theory to Experimental Paradigm

The relative rates of learning intradimensional, extradimensional and control shifts is of particular theoretical relevance. Single-unit S-R theory would predict that the three would be learned at the same rate since "for single-unit theories, the direction (positive or negative) and amount of transfer between consecutive problems depends on the specific stimuli and overt responses which the problems share" (Shepp & Turrisi, 1966, p. 93). Since the specific stimuli used in the training problem are not retained on shift in an extradimensional shift, an intradimensional shift and a control shift, there is no basis for supposing that there is any transfer of instrumental response from one problem to another.

Theories which postulate an intervening process

between the presentation of the overt stimulus and the overt response, namely two-stage theories, chaining theories or mediating response theories, would predict that an intradimensional shift would be learned fastest, a control shift at an intermediate rate and an extra-dimensional shift most slowly. The research literature has been supportive of two-stage theories, since intra-dimensional shifts are learned faster than extradimensional shifts in rats (Shepp & Eimas, 1964), monkeys (Shepp & Schrier, 1969) and humans (Dickerson, 1967; House & Zeaman, 1962; Shepp & Eimas, 1964) provided that in the extradimensional shift the relevant dimension in training is retained as an irrelevant dimension on shift (Shepp & Turrisi, 1966).

The nature of the mediation involved in discrimination shift learning is the problem with which most investigators of the paradigm are most concerned. Kendler and Kendler have been interested in this problem for some time. While they originally avoided being specific about the nature of the mediation involved (1963), more recently they seem to favor the idea that the mediation in shift learning is primarily verbal (Kendler, T.S. & Kendler, H.H., 1966, 1970). A good deal of the data that the Kendlers use to support a verbal mediation hypothesis, however, is suspect since Shepp and Turrisi (1966), Slamecka (1967), and Wolff (1967a) offered some theoretical and methodological criticisms of the

paradigm that was used by the Kendlers. Hence the possible verbal nature of mediation or influence of verbal processes on mediation in shift learning is a question which remains largely unanswered.

More emphasis has gradually come to be placed on the possibility that selective attention is a process which influences the learning of discrimination shift problems. It is argued that children must learn to attend to relevant dimensions before they learn the appropriate instrumental response on discrimination problems. When a shift occurs the factor which transfers from the training to the shift task is the attentional response to the previously relevant dimension. A number of studies (e.g. House & Zeaman, 1962) and theoretical arguments (e.g. Mackintosh, 1965) have applied an attentional interpretation to discrimination shift learning. The current emphasis on selective attention in shift learning is illustrated by Turrisi's (1970) view that:

> . . . basically in 1970 we can still conclude that the Zeamans were correct, and that selective attention is probably the process underlying much of the performance in shift studies (Turrisi, 1970, p. 1).

However, the present writer views the virtual abandonment of interest in the role of language in discrimination shift learning as unfortunate in view of the volume of developmental research and theory which suggests that an important role is played by verbal

processes in discrimination learning. Moreover, there seems to have been too great a tendency on the part of investigators in this area to regard attentional and verbal mediation as mutually exclusive possibilities (Gollin & Saravo, 1969). Blank and Altman (1968) suggest that any procedure, including verbal labelling, which increases selective attention to stimuli will facilitate mediational problem-solving. One of the purposes of this study, then, is to see whether or not language and selective attention are processes which are linked in discrimination shift problems.

CHAPTER III

REVIEW OF RELATED RESEARCH

The Effect of Verbalization on Mediation

The role of language in facilitating a variety of skills, both motor and cognitive, has been explored in a large number of experimental studies carried out over a considerable span of time. In general, language is postulated to play a crucial role in a number of human problem-solving activities. According to Reese and Lipsitt (1970):

> Language remains our richest and most convenient source of cue-producing responses . . . it appears highly reasonable that language, often identified as man's most distinguishing characteristic, should also account for his problem-solving superiority (Reese & Lipsitt, 1970, p. 225).

The research literature concerning the facilitating effect of verbalization on learning is extensive. The present review contains selections which seem of particular relevance to the design and rationale for the present study.

The effect of language on the performance of motor skills in very young children was studied by Luria (1961). He argued that the child becomes able to actively modify his own environment by appropriate speech behavior, and tested his view in a classic study of balloon-pressing. Luria (1961) found, when studying the acquisition of a

motor response (balloon-pressing), that for young children (1.5 to 3 years) verbal instructions have an initiating or releasing function on the motor response, while for older children (4.5 to 5.5 years) they help children to respond conditionally (pressing balloon when light on), but the children still were unable to control or terminate the response. However, teaching the child a speech signal for the motor behavior ("Go") helped children as young as three to initiate, terminate and control their motor response. Luria claimed that weak stimuli were thereby given special signalling properties. Verbal mediation, according to Luria, is a means by which the child modifies the direct influence of external stimuli.

Miller, Shelton and Flavell (1970), however, have been unable to replicate Luria's results with similar apparatus and age groups. They found no evidence for a facilitating effect of verbal behavior on motor behavior and in fact the verbal response seemed to be just another task for the subjects to learn. One surprising finding was that the verbal response tended to be performed after the motor response, hence the verbal response could hardly have been considered to mediate the performance of the motor response. The authors argue that more support is needed for the position that overt verbalization can mediate performance effectively. Many studies claiming to support the effectiveness of verbal mediation such as

transposition or shift tasks, in the view of Miller, Shelton and Flavell, do not actually involve observation of overt verbalizing by subjects but simply infer verbal mediation from the choice behavior of the subjects.

The role of mediation in the task of button-pressing in response to visual stimuli, was examined by Luria (1961). This study involved the presentation of complex visual stimuli, having one strongly salient element on a weaker background which the subject was then required to respond to by pushing a button with his right hand for one stimulus and with his left hand for the other stimulus. If the stimuli, red circle on gray ground and green circle on yellow ground were presented to three to five-year-old children, they readily learned to press with the right hand for the red circle and with the left hand for the green circle regardless of how the backgrounds were changed. Luria found that for younger children up to the age of five, verbal commands did not much affect the salience of the circle but for five to seven-year-olds verbal instructions could modify the salience of the background color so that subjects could respond appropriately to the background rather than to the circle. According to Luria, the study illustrated that verbalization could change natural response-tendencies.

Silverman and Craig (1969) found that instructing subjects to overtly verbalize labels that they had learned

for stimuli (lights) had a different effect for kindergarten and second graders in the learning of an associated motor response. The authors concluded that grade two children mediated regardless of whether they were instructed to verbalize while kindergarten children did not mediate unless they were instructed to verbalize.

Discrimination learning studies provide evidence relevant to the role of verbalization in mediation. Lyubinskaya (cited in Luria, 1969, p. 146) and her associates found that for 13 to 31-month-old children a simple discrimination between color and size was accomplished one-and-a-half to three times faster if accompanied by verbal labelling of the critical attribute. Another problem involving discrimination of complex designs on butterfly wings was accomplished much more easily when words were used to designate different patterns in pre-school children. Samsonova and Khomsova (cited in Luria, 1969) found also that both adults and school children were able to form finer and firmer discrimination in shades of meaning with the help of verbalization. In Luria's words, then, "significant changes in perception can be wrought by words which impart meaning to the stimulus" (Luria, 1969, p. 148).

Weir and Stevenson (1959) gave a problem involving discrimination of the "correct" member of pair of pictures of animals to children varying in age from three to ten

years. One group was given instructions to verbalize the names of the animals when they were first presented, while the other group was given no such instruction. The results indicated that verbalization had a significant facilitating effect on learning to discriminate between stimuli for all age groups studied.

Dickerson (1970) studied the effect of naming relevant and irrelevant stimuli, in a discrimination problem, on the learning of that problem in second-grade children. This study is of special relevance to the present study because it is concerned with the relationship of verbalization and selective attention. Dickerson examined the relationship between labelling cues and dimensions, and attentional responding, by looking at backward learning curves. Four labelling conditions were employed in the study, and the labels employed were nonsense syllables. In group one the subjects learned labels for the two relevant cues; in group two the subjects learned labels for two different cues along the relevant dimension; group three learned labels for the two irrelevant cues and group four learned labels for two different cues from the irrelevant dimension. The performance of the four groups was in the order predicted. The group learning the labels to the two relevant cues learned the problem most rapidly and the group learning labels to the two irrelevant cues learned it most slowly.

According to Dickerson, attention to the relevant dimensions seems to have been facilitated by the first verbalization treatment, while learning labels to the irrelevant dimension is interpreted by him to lead to the acquisition of inappropriate observing responses. The difference in selective attention behavior in the four groups was inferred from backward learning curves which showed that verbalizing cues of the irrelevant dimension lengthened the initial chance portion of the curve. However, no direct measures of observing responses were made.

Transposition tasks which involve the transfer of responses to relations between stimuli rather than to absolute stimulus dimensions have been used to make inferences about the role of verbal mediation in solving problems. Kuenne (1946) argued that his finding of a correlation between verbalization of size relations and transposition supported the view that verbal mediation occurred in the transfer of a relational response. Morris and Tempone (1969) examined the performance of first and third-grade children on a transposition task. At the end of the testing the subject was asked to verbalize how he solved the problem. Grade one and three subjects who verbalized the relevant relation between stimuli tended to show a higher proportion of relationally determined responses. However, third-grade verbalizers gave more

relationally determined responses than first-grade verbalizers. The authors concluded that while younger children had the appropriate mediating response, they could not always integrate it with their motor behavior. The mediating response, in other words, was not as effective in regulating behavior for younger children as for older children.

The reversal shift paradigm has been widely used to study mediation. Kendler and Kendler (1959, 1962, 1963, 1966, 1970) in particular have interpreted the finding that reversal shifts become progressively easier with age, as support for the view that there is a developmental progression from a single-unit manner of responding, to a mediational manner. The Kendlers link this progress to the growth of language in children and argue that verbal mediation is probably involved. However, studies cited here that rely on the relative ease of reversal and non-reversal shifts are extremely difficult to interpret in view of recent criticisms of the paradigm. It is felt, however, that there is value in mentioning some of the key studies with the old paradigm, if only to demonstrate the importance of clarifying the issues with the improved design (Shepp & Turrisi, 1966).

The Kendlers (1963) have carried out a study which they interpret as indicating that simply providing labels for stimuli can facilitate discrimination learning. They

found that verbalization during training made reversal shifts easier for four-year-old children but not for seven-year-old children. They infer that labelling is helpful for the younger children because the younger children do not have labels readily available while the older children are capable of making their own implicit verbal responses. Silverman (1966), on the other hand, using a reversal shift made more difficult by including two irrelevant dimensions, found that verbalizing a description of the stimulus improved reversal learning for both three to four-year-old children and seven to eight-year-old children. He failed, then, to observe the developmental change reported by the Kendlers when using a more difficult reversal shift task. Caution should be used in interpreting these studies since it is no longer thought that ease of reversal learning is an adequate test of mediational transfer (Shepp & Turrisi, 1966; Slamecka, 1967).

Wolff's (1967b) study, in line with current thinking, does not support the Kendler's view that ease of reversal learning is dependent upon the availability of verbal mediation. Wolff examined the effect of three variables on a concept attainment task thought to be dependent on verbal mediation (the Osler concept attainment task) in grade one children. The three variables were ease of reversal learning, verbalization and pre-training. Both verbalization and pre-training had a significant effect on

task performance but ease of reversal learning did not affect it. Wolff concluded that verbal mediation was not involved in reversal learning because there was no relationship observed between ease of reversal shifting and performance on the concept attainment task.

Experiments involving concept formation and its relation to discrimination learning have relevance for clarifying the role of verbal mediation, according to Johnson and White (1967). The existence of a concept of dimensionality is interpreted by them as evidence for the existence of verbal mediation relevant to dimensions. They found that six-year-old children who are able to arrange stimuli along a dimension were able to solve a discrimination problem involving reversal more easily than children who could not do so. The authors conclude that verbal mediation underlies the performance on both tasks. A further experiment (White & Johnson, 1969) confirmed that Dimensionality Test performance was positively correlated with ease of reversal shifting. It is possible to argue with the conclusions of this study on grounds other than the use of a reversal shift. One could equally well claim that performance on the Dimensionality Test was related to the ability to attend to the dimensions involved, which could also be a factor of importance in shift learning.

The preceding discussion has dealt with a selection

of experimental studies concerning the possible importance of verbal cues as mediators for the solution of a variety of different kinds of learning tasks.

Attention as a Mediator

There has been a growing conviction on the part of a number of authors (Zeaman & House, 1963; Turrisi, 1970; Wolff, 1967a) that an important role in discrimination learning is played by selective attentional processes. The study of discrimination shift learning has played a large part in the recent upsurge of interest in selective attention. Moreover, the experimental evidence concerning selective attention in discrimination learning comes mainly from studies which employ the improved experimental shift paradigm, namely the total change design employing intradimensional and extradimensional shifts. Hence one may regard the evidence from these studies less equivocally than evidence from reversal shift studies which have been used so commonly by authors interested in verbal mediation.

Zeaman and House (1963) were among the earliest authors with an interest in child psychology to suggest that discrimination learning involves the acquisition of observing responses as well as instrumental responses. They varied the initial probability of attending to the relevant dimension for theoretical curves using "stat children" by varying the number of irrelevant dimensions in the problem. They argued that the initial probability

of attending to the relevant dimension affected the length of the initial flat portion of the learning curve but not the shape of the final rise to asymptote. Several studies with real children indicated a similar type of curve. Comparing the backward learning curves of retarded children on intradimensional shifts, extradimensional shifts and reversal shifts, House and Zeaman (1962) found that the extradimensional shift performance differed both from the intradimensional shift and reversal shift performance in the length of the initial chance part of the curve. There was a longer initial flat portion on the extradimensional shift than on the intradimensional and reversal shift suggesting that the extradimensional shift involved more observing of the irrelevant dimension after shift than the intradimensional and reversal shifts. Furthermore the rate of learning the different types of shift problems supported an attentional hypothesis since the intradimensional shift required the smallest number of trials to reach criterion, the reversal shift a similar number but slightly larger, and the extradimensional shift a considerably greater number of trials to criterion.

In a study which involved comparison of the performance of subjects on tasks which varied in the salience of the stimuli used, Shepp and Zeaman (1966) found that subjects trained on an easy discrimination problem learned faster than those trained on a difficult

problem. Again when backward learning curves for the two groups were compared it was in the initial flat portion of the learning curve that the groups differed. From their investigation, Shepp and Zeaman concluded that the length of the initial chance-level stage of the performance curve is controlled primarily by attentional processes, while the final sharply rising portion of the curve is determined by the instrumental discriminative learning.

Trabasso, Deutsch and Gelman (1966) found somewhat different results from those described, when comparing extradimensional, intradimensional and reversal shifts in nursery school children. Their paradigm differed from the one commonly used because it employed single-dimensional discriminations. All subjects were shifted to the same final problem in which color was relevant, so that subjects might be reinforced for choosing "red" when presented with a blue stimulus and a red stimulus. On the training task, the reversal shift group was given the same cues with the opposite cue reinforced, "blue" in the present example; the intradimensional shift group was given two different color cues to discriminate; and the extradimensional shift group was given two size cues to discriminate. The extradimensional shift did not therefore involve negative transfer, and the kind of extradimensional shift which they used has more in common with a control shift as described in the present study. The findings were

that intradimensional and extradimensional shifts were learned more easily than a reversal shift for one experiment, and that intradimensional shifts were easier than either reversal or extradimensional shifts in a second study where the stimuli were made more salient (to increase the probability of observing responses).

Dickerson (1967) points out that all studies which have found extradimensional shifts to be easier than reversal or intradimensional shifts, have used a procedure in which the relevant dimension on training does not vary on an extradimensional shift in the shift problem. He argues that when an irrelevant variable is included which changes randomly between trials a reversal shift is always easier. It appears that the irrelevant variable increases the degree of negative transfer of observing responses. Dickerson's own study on shift learning supported this position and upheld an observing response interpretation of shift learning.

A critical test of attentional theory is provided by studies on overtraining since one of the assumptions of an attentional model such as that of Zeaman and House (1963) is that the instrumental response reaches asymptote more rapidly than the attentional response. Hence if the subject is overtrained one would expect that there would be a greater strength for the attentional response than there would be without overtraining. In other words, there would be an increased amount of positive transfer

in an intradimensional shift and an increased amount of negative transfer in an extradimensional shift which should lead to the facilitation of learning for an intradimensional shift and the slowing down of learning for an extradimensional shift. Shepp and Turrisi (1969) confirmed these predictions in a study of retarded children given different amounts of overtraining. However, other findings in this area have been conflicting. Reese and Lipsitt (1970), in a review of the findings on overtraining, sum them up by suggesting that overtraining interferes with extradimensional shifts in retarded children but has essentially no effect in normal children (although one study by Eimas contradicted the general finding). In adult samples overtraining facilitates extradimensional shifts. Reese and Lipsitt do not suggest an explanation for the interaction between mental age and the effect of overtraining.

Only a small number of studies have been located which have employed the direct measurement of observing responses in addition to examining the acquisition of instrumental responses in discrimination learning problems. White and Plum (1964) measured the eye movements of nursery school children while they solved discrimination learning problems. They found that the eye movements of subjects increased as subjects approached criterion and for a few trials at the onset of criterion. The study also indicated

that children given discrimination problems which were interesting and relatively easy showed more eye movements than children given harder discrimination problems. It was suggested that the study demonstrated that better discrimination learning was associated with a greater degree of stimulus scanning. White and Plum interpret their findings as support for Zeaman and House's theory.

Rydberg and his associates have carried out a number of studies on the tactual observing responses of adults in discrimination learning tasks (Rydberg, 1969; Rydberg & Arnberg, 1969a, 1969b; Rydberg, Kashdan & Trabasso, 1966). They devised an apparatus which recorded the amount of time subjects spent touching stimulus objects during discrimination learning. In a typical task the subject had to learn which of three dimensions was relevant and press an appropriate button for a given value of the dimension. Rydberg and his fellow workers found that relevant observing was at chance during the first part of learning and increased before the problem was solved and during criterion responding, while it fell back to chance again when the rule was changed. They also found over-learning to have the effect of increasing the percentage of relevant observing responses. The data on observing responses was found to agree with the verbal reports subjects made of their hypotheses and use of cues.

The studies reviewed concerning the role of

attention in discrimination learning have included studies on shift learning which are of value because shift problems allow the study of mediational transfer from one problem to another, and studies of discrimination learning where direct measures of observing responses were employed. The value in using direct measurement of observing responses seems to lie in the fact that observing responses are variables which appear to be related to selective attention which are able to be independently controlled, measured and defined (Wyckoff, 1952). Experiments in discrimination learning where attentional deficits have been inferred from different rates of learning (e.g. Zeaman & House, 1963) have been criticized by Mostofsky (1968) who claims that their argument is circular. He feels that it is fallacious to use attention to *explain* differences in learning and at the same time *infer* from the nature of the learning that there is an attentional deficit. He favors the use of operationally defined observing responses which can be objectively and independently measured, in order to overcome the problem of circularity.

Summary of Research Findings

In the studies reported in this chapter, there has been some evidence cited which supports the view that language aids the learning of some different kinds of responses, such as the acquisition and control of a motor response or the discrimination of visual stimuli. Whether

or not instructions to verbalize are more helpful for younger than for older children is still not certain though some studies support the view that external instructions to verbalize are only facilitating up to the age of about seven years (Kendler, 1963; Silverman & Craig, 1969). It seems that a crucial condition which influences the effectiveness of verbalization for older children is the difficulty of the task (Silverman, 1966; Weir and Stevenson, 1959). Neither does the research literature provide any clear answer about the manner in which verbal processes affect the learning of overt instrumental responses. The Kendlers (1963) claimed that verbalization strengthens verbal mediational chains (and hence increases the speed of reversal learning because it encourages mediational transfer) but there have been so many criticisms of the paradigm that they use, that their hypothesis must be regarded as unconfirmed. Luria (1969) suggests that the effect of verbalization is to change the attentional value of the stimulus but unfortunately a recent replication (Miller, Shelton & Flavell, 1970) failed to reproduce Luria's findings. One study (Dickerson, 1970) gives tentative support to Luria's position but the study relied on a Zeaman and House type of interpretation using backward learning curves without any direct measurement of observing responses. It seems, therefore, that the question of the role of language in mediation needs further study with the

use of a more appropriate mediational paradigm. Furthermore, if language has an effect on selective attention, direct measurement of some aspect of selective attention during problem-solving would be a more effective method of studying this issue than measuring learning rates. Finally, the actual overt verbalization of stimulus dimensions is a desirable aspect of any study which concerns the role of language as a mediator, since it can be ascertained that verbalization is actually occurring.

There is also a good deal of support for the theory that attention is a crucial component of discrimination shift learning. Differences in performance on shift learning problems are thought by a number of authors (e.g. Zeaman & House, 1963) to be due in large part to the differential transfer of selective attentional responses. It is argued that a subject learns the appropriate instrumental response to a cue by first learning an appropriate observing response to a relevant dimension. The bulk of the data used to support this position comes from relative rates of learning shift problems which differ in the amount and direction of mediational transfer. Backward learning curves are used to illustrate the view that negative transfer of attention (for example in an extradimensional shift) leads to a longer initial chance period of responding which is said to be due to observing irrelevant dimensions, while the final rising part of the curve due to

the acquisition of the instrumental response is similar for both negative and positive transfer of attention. Unfortunately, other mediational theories such as verbal ones, predict similar learning curves and learning rates to those obtained by Zeaman and House. Most of the studies cited do not provide the direct measurement of selective attention necessary to verify an attentional hypothesis.

White and Plum (1964) and Rydberg and his associates (1966, 1969) have measured visual observing responses and tactual observing responses respectively in discrimination learning tasks. They were able to show that the instrumental response was related to the observing response since relevant observing increased just before criterion and during criterion responding. The latter studies add considerably to the strength of an attentional hypothesis. So far, however, there does not seem to have been any direct study of observing responses in tasks involving mediational transfer such as shift problems. Carrying out such an investigation is a further step in studying the question of whether mediation in discrimination shift learning involves selective attention.

Statement of the Problem

The present study was an investigation of the relative speed of learning and the relative number of observing responses in three different shift problems

(intradimensional, extradimensional and control shifts) under three different verbalization conditions (spontaneous verbalization, assigned verbalization and no verbalization). The purpose of the study was to examine the question of whether observing responses appear to be involved in mediational transfer problems, and whether verbalization conditions encourage such mediational transfer. Grade one children were administered a tactual discrimination shift problem. The number of tactual observing responses to both relevant and irrelevant dimensions and the number of trials to criterion was assessed under the different experimental conditions.

CHAPTER IV

DEFINITIONS AND HYPOTHESES

Definitions

General Terms

Cue. A particular stimulus value (e.g. square or circle) from a single class of stimuli which comprises a dimension (e.g. form).

Dimension. Any stimulus class (e.g. form or texture) within which a particular stimulus has a value on a scale, the range of values comprises the dimension.

Irrelevant Dimension. A dimension used on a discrimination problem where choices of both cues along the dimension are equally correlated with reinforcement.

Observing Response. A response which results in the exposure of a subject's sense organs to stimulus cues (e.g. eye movement, tactual observing responses).

Relevant Dimension. A dimension used on a discrimination problem where the choice of one cue from the dimension is always reinforced.

Shift. A discrimination learning problem where transfer from a training task to this task is believed to occur in varying degrees depending on the type of shift.

Independent Variables

Assigned Verbalization Group. The treatment group which was instructed to overtly verbalize labels provided by the experimenter for relevant and irrelevant cues on the training task.

No Verbalization Group. The treatment group which was given no instructions to overtly verbalize labels for the relevant and irrelevant cues on the training task.

Spontaneous Verbalization Group. The treatment group which was instructed to overtly verbalize their own labels for relevant and irrelevant cues on the training task.

Control Shift. A discrimination learning problem which consists of a training task followed by a shift task on which both the dimensions and cues are entirely different from those on the training task.

Extradimensional Shift. A discrimination learning problem which consists of a training task followed by a shift task (using different cues of the same dimensions) where a dimension which was irrelevant during training becomes relevant on shifting, while the dimension relevant during training becomes irrelevant on shifting.

Intradimensional Shift. A discrimination learning problem which consists of a training task followed by a

shift task (using different cues of the same dimensions) where the same dimensions that were relevant and irrelevant on training remain relevant and irrelevant on shifting.

Dependent Variables

Coupling. A change in tactual observing from the relevant or irrelevant cue of one stimulus to the relevant or irrelevant cue of the other stimulus so that the two stimuli are coupled or compared.

Non-Verbalizer. A person who is unable to verbalize correctly the solution to either the training or the shift task at the end of the shift task.

Percentage Relevant Observing per Trial. The relative number of relevant observing responses per trial compared to the number of total observing responses per trial expressed as a percentage.

Pre-shift Trials to Criterion. The total number of trials from the initial presentation of stimuli on the training task to the point where a subject has reached criterion (nine out of ten successive correct choices).

Post-shift Trials to Criterion. The total number of trials from the shift to the point where a subject has reached criterion.

<u>Relevant Observing per Trial</u>. The mean number of observing responses made by a subject over a given period of trials to the relevant dimension per trial.

<u>Total Observing per Trial</u>. The mean number of observing responses made by a subject over a period of trials to both relevant and irrelevant dimensions per trial.

<u>Verbalizers.</u> A subject who is able to correctly verbalize the solution to either the training or shift task or both at the end of the shift task.

Hypotheses

<u>Rationale</u>. Several studies (Kendler, 1963; Silverman & Craig, 1969) indicate that discrimination learning is facilitated when the stimuli to be discriminated are given a verbal label of some kind. Luria (1969) has suggested that verbalization is an effective aid to discrimination because it directs the attention of the child onto the discriminative stimuli. It is therefore argued that a discrimination learning task will be more rapidly learned by groups given a verbalization treatment than by a group given no such treatment on the assumption that the attention of the verbalization groups has been directed more quickly onto the stimulus cues. In other words discrimination learning will be facilitated and

selective attention encouraged when subjects are required to verbalize.

Hypothesis 1. Subjects who are instructed to verbalize the cues of the relevant and irrelevant stimulus dimensions before making each response choice will learn the training task more rapidly than subjects who are not given such instructions. Subjects in verbalization groups will also observe the stimuli to be discriminated more than subjects in the no verbalization group.

1.1. The mean number of pre-shift trials to criterion will be less for spontaneous and assigned verbalization groups than for the no verbalization group.

1.2. The means of the spontaneous verbalization and assigned verbalization groups on relevant observing per trial, total observing per trial and couplings per trial will be greater than the means for the no verbalization group.

Rationale. An intradimensional shift is said to involve positive transfer of mediation since the dimension which was relevant during training was also relevant upon shifting. That is a mediating chain is presumed to have been learned during the training task which is also appropriate to the shift task. Conversely an extra-dimensional shift is said to involve negative transfer of mediation since the dimension relevant before shifting

becomes irrelevant upon shift and the previously irrelevant dimension becomes relevant. That is a mediating chain learned on the training task must be extinguished and a new mediational chain, appropriate to the newly relevant dimension must be learned. Finally, a control shift is believed to involve no transfer of mediation since different dimensions are used on the training task from the ones used on the shift task. That is a new mediational chain must be established but it is not necessary to extinguish an inappropriate mediating chain.

The preceding theoretical argument suggests, then, that the order of reaching criterion after a shift should be the intradimensional shift group first, the control shift group second and the extradimensional shift group third. If part of the mediation involved in shift learning is related to selective attention, one would expect the intradimensional shift group to observe the relevant dimension most immediately after the shift, the control shift an intermediate amount, and the extradimensional shift group least. In the present study, however, such an order of speed of learning and amount of observing the relevant dimension can only be predicted for the no verbalization group. The reason for this lies in an expected interaction effect between verbalization treatment and shift condition.

For reasons which will be explained under the

rationale for hypothesis 3, verbalization treatment is expected to increase the speed of learning and relevant observing immediately after the shift for both intradimensional and extradimensional shifts but to have no effect on these variables for the control shift. One would therefore expect the intradimensional and extradimensional shift to retain their relative position in speed of learning and amount of relevant observing immediately after the shift, since they are both influenced in a similar manner by verbalization, but one would expect a control shift to be closer to an extradimensional shift in speed of learning and amount of relevant observing immediately after the shift. In other words, the control shift cannot be expected to retain its intermediate position between the intradimensional and extradimensional shifts in _trials to criterion_ and _relevant observing per trial_ immediately after the shift, when verbalization during training occurs for the three shifts.

Hypothesis 2. For subjects in the no verbalization group, an intradimensional shift will be learned more rapidly than a control shift and an extradimensional shift will be learned more slowly than a control shift. For subjects in the no verbalization group, there will be a relatively greater amount of observing to the relevant dimension immediately after the shift for the intradimensional shift than for the control shift and a

relatively smaller amount of observing responses to the relevant dimension for the extradimensional shift than for the control shift. For subjects in the spontaneous verbalization and assigned verbalization groups, an intradimensional shift will be learned more rapidly than an extradimensional shift and an intradimensional shift will be learned more rapidly than a control shift, but there will be no difference in the rate of learning of extradimensional and control shifts. For subjects in the spontaneous and assigned verbalization groups, there will be a greater relative amount of observing to the relevant dimension immediately after the shift for the intradimensional shift than for the control shift and for the intradimensional shift than for the extradimensional shift, but there will be no differences in the relative amount of relevant observing after the shift for the extradimensional and control shifts.

2.1. For the no verbalization group, the mean post-shift trials to criterion will be greatest for the extradimensional shift, intermediate for the control shift and least for the intradimensional shift.

2.2. For the spontaneous and assigned verbalization groups, the mean post-shift trials to criterion will be greater for the extradimensional shift than for the intradimensional shift, and greater for the control shift than for the intradimensional shift, but the same for the control

shift and the extradimensional shift.

2.3. For the no verbalization group, the mean relevant observing per trial and mean percentage relevant observing per trial in the first ten trials after the shift will be greatest for the intradimensional shift, intermediate for the control shift and least for the extradimensional shift.

2.4. For the spontaneous and assigned verbalization groups, the mean relevant observing per trial and the mean percentage relevant observing per trial in the ten trials after the shift will be greater for the intradimensional than for the extradimensional shift and greater for the intradimensional shift than for the control shift, but the same for the control shift and the extra-dimensional shift.

Rationale. Verbalization treatments in the present study involved reinforcement (social) of verbal responses to the cues of both relevant and irrelevant dimensions, preceding the instrumental choice response to the relevant cue (which was also reinforced). In Luria's view, verbalization directs attention, hence one might expect verbal responses to the cues of relevant and irrelevant dimensions to direct observing responses to those cues. The effect of verbalization, then should be to establish a complex chain of mediators, including verbal and observing responses and the associated response-produced cues, to the

cues of the relevant and the irrelevant dimensions, terminating in the instrumental choice response. Due to the additional reinforcement of the choice response, it could be expected that mediating responses to the relevant dimension would be strengthened more than the mediating responses to the irrelevant dimensions. On the other hand, if the mediating responses to the irrelevant dimension occur on the same chain as mediating responses to the relevant dimension, chaining theory (Kendler & Kendler, 1968; Reynolds, 1968; Staats & Staats, 1963) leads one to expect that they too would be strengthened to some degree, since successive stimuli within the chain are said to assume reinforcing functions which are derived from reinforcement of the final instrumental response. The mediational chains built up by verbalization might be represented thus:

S_1

Irrelevant dimension   Relevant dimension   Instrumental response

$$r_v - s - r_a - s - r_v - s - r_a - s - R$$

S_2 S_v S_v S_r (social) 1st ten S_r (tokens)

Training stimuli   Verbal instructions   Reinforcing stimuli

The essential difference between the mediational chain built up in verbalization treatments and the mediational chain built up in the no verbalization treatments is that in the latter it would be expected that extinction of mediators to the irrelevant dimensions would occur, but also mediation to the relevant dimension should be stronger in the verbalization groups than in the no verbalization group. It should, therefore, be predicted that the effect of verbalization on the instrumental choice responses and the mediating responses should be similar for both intradimensional and extradimensional shifts. For subjects in verbalization groups, however, the intradimensional shift should still be learned more rapidly than the extradimensional shift because mediation to the relevant dimension must be extinguished (or relocated in the chain) in an extradimensional shift. In intradimensional and extradimensional shift groups given verbalization treatment a similar mediational chain has been established for the two groups during training. Verbalization should therefore facilitate the learning of a new instrumental choice response on an intradimensional shift since the mediation to the relevant dimension is stronger than in the no verbalization condition, because it has received additional reinforcement. Verbalization should also facilitate the learning of a new instrumental choice response in an extradimensional shift since

mediation to the newly relevant dimension has already been learned, while in the no verbalization group it has been extinguished. However the mediation to the previously relevant dimension must either be extinguished or relocated in an earlier part of the chain. Verbalization would not be expected to have any effect on the control shift, since there is no direct transfer of mediation from the first to the second problem. In a control shift an entirely new mediational chain must be learned. The different expectations concerning a control shift with respect to the effect of verbalization should lead to an interaction between shift and verbalization.

Hypothesis 3. Among spontaneous, assigned and no verbalization groups performing a control shift there should be no differences in rates of learning, and there should be no difference in amount of observing responses immediately after the shift. There will be more rapid learning and a greater number of observing responses immediately after the shift for spontaneous and assigned verbalization groups than for the no verbalization group performing an intradimensional or an extradimensional shift.

3.1. There will be no difference in the mean post-shift trials to criterion for spontaneous, assigned and no verbalization groups performing a control shift.

3.2. The mean post-shift trials to criterion will

be less for spontaneous and assigned verbalization groups than for the no verbalization group performing an extra-dimensional or an intradimensional shift.

3.3. There will be no difference in the mean <u>relevant observing per trial</u>, <u>total observing per trial</u> and <u>couplings per trial</u> in the ten trials after the shift, for spontaneous, assigned or no verbalization groups performing a control shift.

3.4. The mean <u>relevant observing per trial</u>, <u>total observing per trial</u>, and <u>couplings per trial</u> in the trials after the shift, will be greater for spontaneous and assigned verbalization groups than for the no verbalization group performing an extradimensional or an intradimensional shift.

<u>Rationale</u>. Whether or not children are able to verbalize the correct dimension after solution of a discrimination learning task has been taken as an indicator of whether or not they have the appropriate verbal mediation (Kendler, 1963; Morris & Tempone, 1969). It would therefore be expected that children who can verbalize the correct solution to a discrimination problem would be faster learners and better attenders than children who cannot verbalize the correct solution. It would also be expected that children who can verbalize the solution to the problem in this particular study are more likely to have been in verbalization treatment groups.

Hypothesis 4. Verbalizers should learn the training and shift problems faster than non-verbalizers and they should observe the stimulus cues more than non-verbalizers in the trials immediately following shift.

4.1. The mean pre- and post-shift _trials to criterion_ will be greater for non-verbalizers than for verbalizers.

4.2. The mean _relevant observing per trial_, _total observing per trial_, and _couplings per trial_ will be greater for verbalizers than for non-verbalizers.

4.3. There will be a greater number of verbalizers in the spontaneous and assigned verbalization groups than in the no verbalization group.

CHAPTER V

METHOD

Sample

Grade one children from three schools in the Edmonton Public School system (representing a range of socioeconomic levels) were tested until the required 108 subjects were obtained. During the testing, seventeen subjects were lost because of failure to learn the training task. Of these seventeen, ten had been assigned to no verbalization, five to assigned verbalization and two to spontaneous verbalization; twelve to the intradimensional shift, four to the extradimensional shift and one to the control shift. Three subjects were also lost because of spoilt data. Subjects were randomly assigned to each of the nine experimental groups, with twelve subjects in each group.

The subjects ranged in age from five years eleven months to eight years eleven months and the mean age of the sample was seven years two months. The mean Lorge-Thorndike I.Q. for the sample was 98 (standard deviation = 11.8).

Design and Analysis

The principal analysis employed was a three by three analysis of variance (Winer, 1962), the independent variables being type of shift (intradimensional shift, extradimensional shift and control shift) and type of verbalization treatment (spontaneous verbalization, assigned verbalization and no

verbalization). The following dependent variables were examined during the first ten and total trials of the pre- and post-shift tasks:

(a) Trials to criterion.

(b) Relevant observing per trial.

(c) Total observing per trial.

(d) Percentage relevant observing per trial.

(e) Couplings per trial.

A one-way analysis of variance was carried out to examine the effect of solution verbalization (verbalizers and non-verbalizers) on the dependent variables. The relation between solution verbalization and verbalization was assessed by carrying out chi square tests for independence on the frequency of subjects in verbalization treatment and solution verbalization groups.

Two-way analyses of variance were performed on the dependent variables in order to determine whether certain extraneous variables (sex, dimension and training) interacted with the manipulated independent variables. The following pairs of independent variables were used to find out if there were any interactions:

(a) Verbalization treatment x sex.

(b) Verbalization treatment x dimension.

(c) Verbalization treatment x training.

(d) Shift x sex.

(e) Shift x dimension.

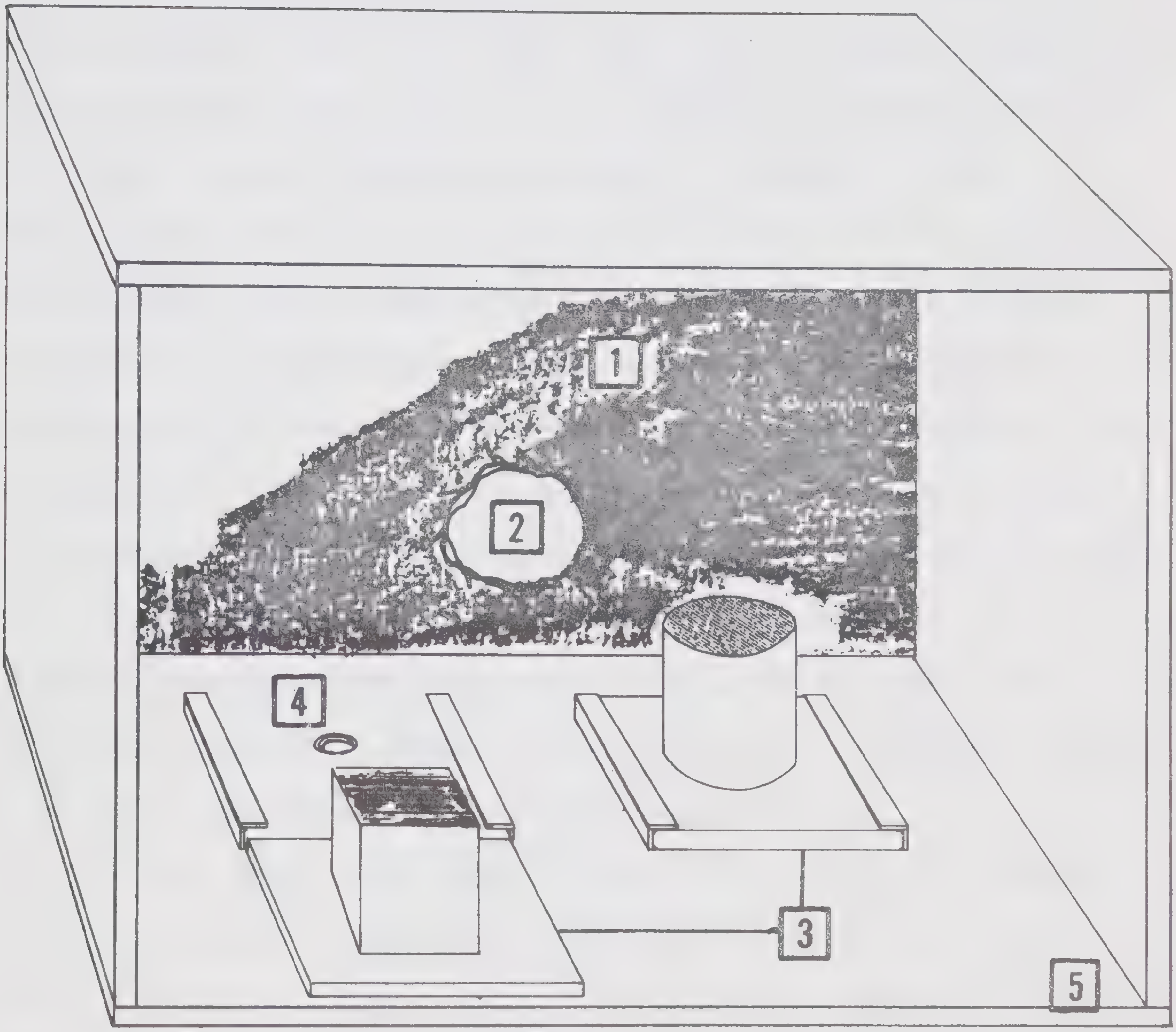
(f) Shift x training.

Apparatus

The discrimination learning apparatus (see Figure 2) consisted of a small wooden box, on the base of which were slots into which two stimuli could be fitted. When the stimuli were in place, each one covered a small shallow well for the reinforcer. This well was exposed when the stimuli were pushed forward by the subject. One side of the apparatus was open to the view of the experimenter who could therefore bait the reinforcement wells and provide the appropriate order and positioning of stimulus presentation. On the same side of the apparatus, behind the experimenter's shoulder, a Sony Video camera, model CVC-2100A, was positioned so that it was focused on the interior of the apparatus. The video camera was attached to an Ampex one-inch video-tape-recorder, model VR-5100, to provide a permanent record of tactual observing responses. The subject sat on the other side of the apparatus, screened from sight of the stimuli by an opaque curtain with a hole in the middle of it. The subject's hand was placed through the hole so that he was able to extend his hand into the box and easily move his hand from one stimulus to the other without being able to see the stimuli at all.

Recording of Data

The tactual observing responses were recorded on Memorex one-inch videotape and scored later by the experimenter.



1. Opaque curtain.

2. Hole for subject's hand.

3. Stimuli.

4. Reinforcement well.

5. Side of apparatus open to experimenter and TV camera.

FIGURE 2

SCHEMATIC VIEW OF DISCRIMINATION LEARNING APPARATUS

Stimuli

Six pairs of stimuli utilizing the dimensions of form, texture, size and number were used in this study. Each stimulus used for form and texture discriminations was cut from a piece of wood two inches in depth, in the appropriate form. The surface area of the texture and form stimuli was approximately two and one-half inches square. Completely covering the uppermost surface of the form was material of a texture which varied from one stimulus to the other. The texture was placed on top of the form because the scoring method necessitated that the dimensions of form and texture be separated. In pilot work, texture was even further separated from form by being placed at the base of the form stimulus. Under these conditions, however, texture was found to be much less salient than form.

The size and number stimuli for the control shift training task were cut from a cylindrical piece of wood with a diameter of one and a half inches. The size dimension was varied by cutting pieces of different height, and the number dimension was varied by attaching different numbers of furniture nails (with a rounded top) on the surface of the stimulus.

Each stimulus was attached to a piece of beaverboard four inches square which slid into the base of the apparatus.

(1) The first two pairs of stimuli, pairs A and B, were used for the training tasks of the extradimensional shift and the intradimensional shift. They consisted of:

(a)	Circle with furry texture.	A
(b)	Square with smooth texture (aluminum foil).	A
(c)	Circle with smooth texture.	B
(d)	Square with furry texture.	B

(2) The second two pairs of stimuli, pairs C and D, were used for the training task of the control shift. They consisted of:

(a)	A six inch tall stimulus with three protrusions on the surface.	C
(b)	A two inch tall stimulus with one protrusion on the surface.	C
(c)	A six inch tall stimulus with one protrusion.	D
(d)	A two inch tall stimulus with three protrusions.	D

(3) The third two pairs of stimuli, pairs E and F, were used for the shift tasks of the extradimensional, intradimensional and control shifts. They consisted of:

(a)	Triangle with sandpaper texture.	E
(b)	Rectangle with corrugated texture (plastic).	E
(c)	Triangle with corrugated texture.	F
(d)	Rectangle with sandpaper texture.	F

Experimental Treatments

Discrimination Shift Tasks

The discrimination learning tasks for this study were tactual discriminations using the dimensions of form, texture, size and number. The stimuli and dimensions used for each shift condition have already been described. The subject was seated facing the experimental apparatus and told to put his hand through the hole in the curtain. The experimenter baited the correct stimulus with a reinforcer (a token placed in the well underneath the stimulus) and told the subject to feel the stimuli carefully and to choose the "winner" (see Appendix A for Instructions). It was made clear that the correctness of a stimulus choice depended on some quality of the stimulus. If the subject was in the spontaneous or assigned verbalization group he was asked to verbalize the stimulus cues at this stage. The subject was then told to make a response by sliding forward the stimulus he thought was correct and feeling in the hole to see if there was a token in it. If the subject made a correct response, the experimenter took the token from the subject's hand that was extended into the apparatus and passed it around the side of the apparatus into the subject's other hand. Then the experimenter baited the well for the next trial and so on, until the subject reached criterion, which was defined as nine out of ten successive correct responses.

Upon reaching criterion on the training task, subjects were shifted to the second problem without any break in the procedure. They were not told that a new problem had been introduced. Subjects were trained on the new task until they had reached criterion or 40 trials, whichever came first.

The two pairs of stimuli used in a particular problem were presented in a modified Gellerman series (see Appendix B) in order to avoid greater than chance level success for simple position habits such as single alternation or double alternation. For each discrimination task, half of the subjects were rewarded on one dimension (half of these to each cue of that dimension) while the other half were rewarded for responding to the other dimension (half to each cue of that dimension). For example, for the stimulus pairs A and B, one quarter of the subjects were rewarded for responding to _square_, one quarter for responding to _furry_, one quarter for responding to _circle_ and one quarter for responding to _smooth_. Table 1 shows the distribution of relevant dimensions and cues among subjects.

Intradimensional Shift. Figure 3 shows examples of the shift tasks used. The intradimensional shift involved training on stimulus pairs A and B with one dimension relevant and one dimension irrelevant. For example, if form was relevant and texture was irrelevant, the positive

TABLE 1

NUMBER OF SUBJECTS ASSIGNED TO RELEVANT CUES AND DIMENSIONS FOR EXTRADIMENSIONAL, INTRADIMENSIONAL AND CONTROL SHIFTS

(a) Training Task:

	IDS and EDS				CS			
	Form		Texture		Size		Number	
	Square	Circle	Smooth	Rough	Big	Small	One	Three
Dimension	36		36		18		18	
Cue	18	18	18	18	9	9	9	9

(b) Shift Task:

	EDS, IDS and CS			
	Form		Texture	
	Triangle	Rectangle	Rough	Smooth
Dimension	54		54	
Cue	27	27	27	27

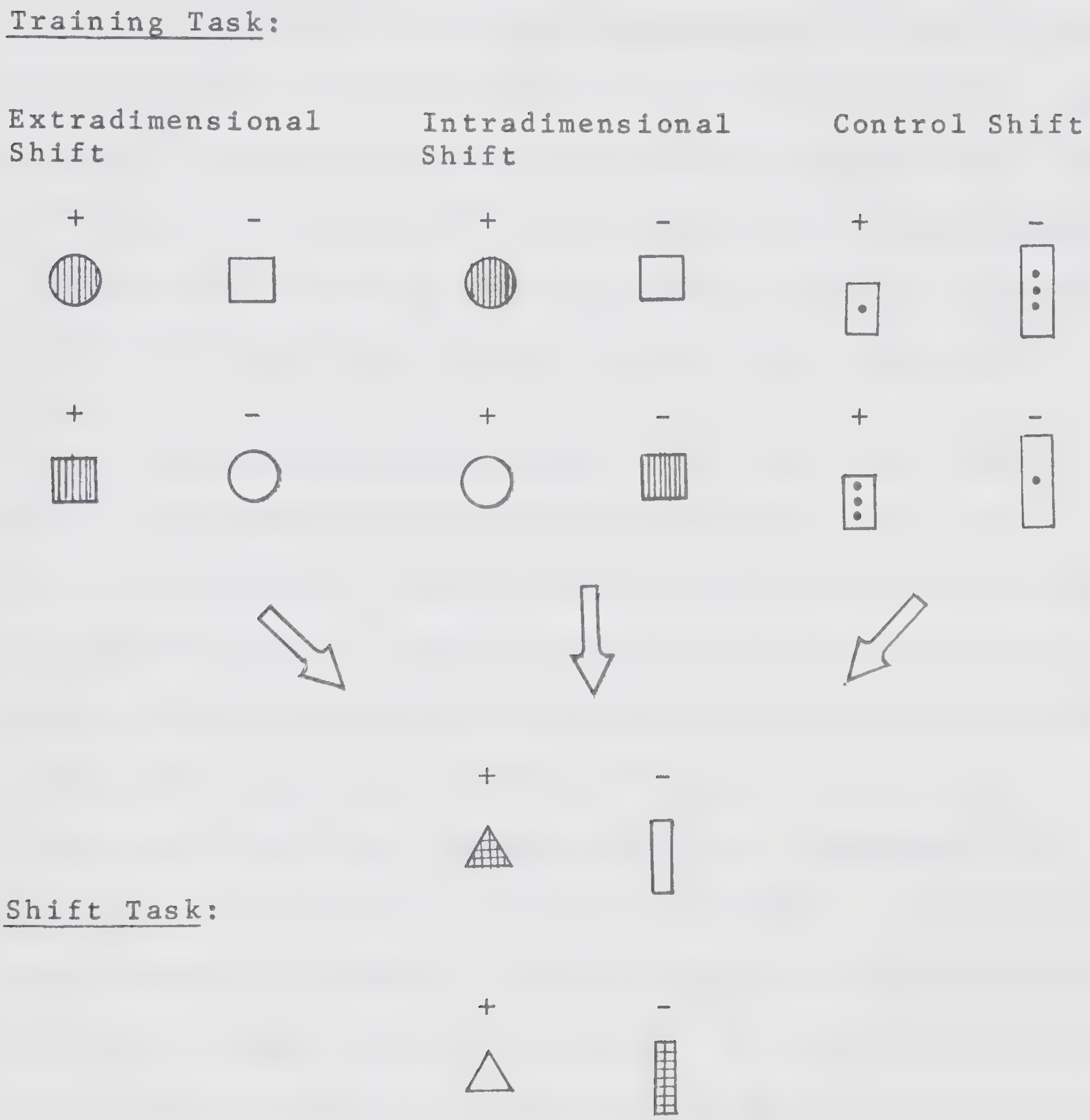


FIGURE 3

EXAMPLES OF THREE DIFFERENT SHIFT TASKS
(DIAGRAMMATIC)

cue _square_ might be reinforced regardless of whether the square had a rough or smooth surface. When the subject had reached criterion on the training task he was shifted to a second problem involving stimulus pairs E and F where the dimension which was relevant to solution was the same one that had been relevant during the training task. For example, a subject might have learned to choose _square_ on training and upon shift have to learn to choose _triangle_. Again the irrelevant dimension would have been texture.

Extradimensional Shift. The extradimensional shift also involved training on stimulus pairs A and B with the same procedure during training as for the intradimensional shift. Again when the subject had learned the initial problem he was shifted onto a second problem using stimulus pairs E and F. However, in an extradimensional shift the reinforcement contingencies were changed. The dimension which was relevant on the training task became irrelevant on shift and the irrelevant training dimension became relevant on shift. For example, if a subject had learned to choose _square_ on the training task and to disregard the texture of the square, he might have to learn to respond to _rough_ on the shift and disregard the form of the stimulus.

Control Shift. Stimulus pairs C and D were used for the training task of the control shift. Subjects had to

learn to respond to a relevant dimension and disregard an irrelevant dimension as in the training tasks of the extradimensional and intradimensional shifts. For example, if size was relevant, a subject might have to respond to large and disregard the number of protrusions on the stimulus. Upon reaching criterion, subjects were shifted to a second problem, using stimulus pairs E and F, which had entirely different stimulus dimensions. The shift problem was presented in the same manner on the control shift as for the intradimensional and extradimensional shifts.

Verbalization Treatments. There were three types of verbalization condition in this study--spontaneous verbalization, assigned verbalization and no verbalization conditions. The no verbalization group was a control group which was given no verbalization instructions. The spontaneous and assigned verbalization groups were given instructions (see Appendix A) to verbalize labels for cues from both stimulus dimensions. The subjects were prompted to produce verbalizations for the first ten trials of the training task and were verbally reinforced by "Good" or "Yes" only when they produced their verbal response to cues on both relevant and irrelevant dimensions. The subject's verbal response was made after the subject was presented with the stimuli on a particular trial and before the subject made his instrumental choice response. If the

subject verbalized only one dimension the experimenter withheld approval and asked the subject to tell her what else was different about the stimuli. The subjects were prompted to verbalize for the first ten trials in order to produce as strong as possible a tendency to verbalize both dimensions, since it was observed during pilot work that subjects soon ceased overtly verbalizing the cues if they were given instructions to verbalize only before the first trial. However, prompting together with social approval on the first ten trials produced a strong overt verbalizing response which usually continued right through the training task and often into the shift task as well.

The spontaneous and assigned verbalization groups differed in the manner that labels were given to cues. In the spontaneous verbalization group subjects were asked to provide their own labels for the cues, whereas in the assigned verbalization group the experimenter gave the subject an appropriate set of labels for the stimuli. The labels for the stimulus pairs used for the assigned verbalization group were as follows:

(a) "The circle with the furry top." (b) "The square with the smooth top."	Stimulus pair A
(c) "The circle with the smooth top." (d) "The square with the furry top."	Stimulus pair B
(e) "The big one with three bumps on it." (f) "The little one with one bump on it."	Stimulus pair C

(g) "The big one with one bump on it.")
)
(h) "The little one with three bumps) Stimulus
on it.") pair D

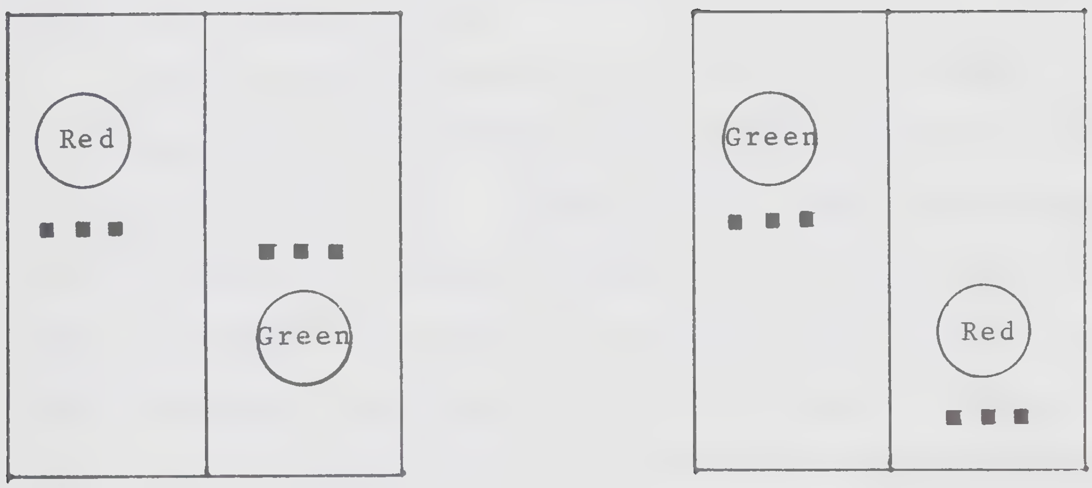
Solution Verbalization. When the subject had solved both the training task and the shift task, he was asked if he could tell the experimenter which cue was the "winner" for the shift task and then for the training task. If the subject was able to name the correct cue in some way (e.g. "It was the round one.") he was classified as being a verbalizer, and if the subject was unable to name the correct cue he was classified as being a non-verbalizer.

Pretraining. All subjects were exposed to a brief period of pretraining. Some procedure of familiarizing subjects with the experimental situation, such as the present procedure, is not uncommon in discrimination learning studies (e.g. Brown & Smith, 1967). Pretraining was felt to be necessary because it was observed during pilot work that the experimental tasks were quite difficult for grade one children, and it was felt that a procedure which might decrease the number of subjects lost because of failure to learn the initial training task was desirable. The intent of the pretraining was as a teaching device such that subjects would understand that the "game" involved choosing one of two stimuli and that the choice should be made on the basis of some cue of the stimulus which remained the same on the "winner" while other

irrelevant cues varied. The task was also a good deal easier than the experimental task and it was expected that the certainty of success on this task would generally foster a favorable attitude toward the subsequent experimental task.

The pretraining apparatus (designed and used previously by Knowles and Boersma, 1968) allowed the presentation of pairs of visual stimuli in two small windows. In this study the subject simply made a choice by pointing to one of the stimuli (see Appendix A for instructions) and was verbally reinforced by "Good" for making correct responses. The stimuli consisted of two pairs of visual stimuli (see Figure 4) involving the dimensions of color and position, chosen because there was no direct transfer of learning on these dimensions to the experimental task.

The dimension of position was made relevant for all subjects while color was irrelevant for all subjects. The positive cue was decided on the basis of the subject's first choice which was always reinforced. If the subject happened to choose a stimulus with the dots on top, <u>top</u> was made the relevant cue for the rest of the pretraining trials. On the first presentation the child was asked if he could guess the winner, but on the second trial, regardless of whether the choice was correct or not, the experimenter explained why the choice was either correct



Stimulus Pair 1

Stimulus Pair 2

FIGURE 4

PRETRAINING STIMULI

or incorrect. Pretraining was given until five correct response choices had been made.

Training. Any subject who reached the fortieth trial without approaching criterion (was still making errors) was given a special training procedure. The training consisted of directing the child's observation to the relevant dimension. Forty subjects were given training on the initial training task.

The training procedure was given on a maximum of four trials. On the subject's first error after trial 40 he was directed to feel the stimulus again. The experimenter actually guided the subject's hand to make observing responses to the two cues of the relevant dimension and told him when he was observing the correct cue. For example, if the correct cue was furry the experimenter placed the subject's finger-tips on the furry texture and informed him that this was the "winner" without naming the cue. The subject's finger-tips were also placed on the incorrect cue and he was told that this was the "loser".

Non-Learners. Some subjects were excluded from this study because they could not learn the initial training task in the trials allowed. An attempt was made to minimize the number of subjects lost in this way through the use of pretraining and training. Considerations of availability of time and apparatus and loss of motivation on the part of the

subjects necessitated the exclusion of subjects who did not learn after the training procedure. Specifically, subjects were discarded on their first error after the fiftieth trial, unless they appeared to be approaching criterion.

Reinforcement. The reinforcers used in this study were tokens made from lima beans, dyed and varnished. The beans fitted into the reinforcing wells and could be easily removed by the subjects. At the beginning of the task subjects were told that at the end of the game they would be able to exchange their tokens for some candy or cheap plastic toys (which were displayed in a prominent position in the experimental room). The positive stimulus in the stimulus pair always had a token in the well underneath it while the negative stimulus had an empty well underneath it. Each subject was given approximately the same reward at the end of the session.

Measurement of Dependent Variables

The focus of interest in this study was upon the effect of the various treatments, firstly upon the speed with which subjects learned discriminations and secondly on the selective attention directed towards the stimulus cues. The response measure commonly used in discrimination learning studies is the number of trials it takes the subject to reach criterion. Accordingly, trials to criterion

was one dependent measure used in this study.

The use of tactual observing responses as a measure of selective attention was suggested in studies by Rydberg, 1969; Rydberg and Arnberg, 1969a, 1969b; and Rydberg, Kashdan and Trabasso, 1966. In the present study, number of tactual observing responses directed to the various cues was the basic measure of observing since the method of scoring was not suitable for calculating actual time spent observing. The number of observing responses to the two cues from both the relevant and irrelevant dimensions, and the number of couplings or shifts from one dimension to another were the basic data for the calculation of dependent variables.

Specific hypotheses in the study pertain to both the increased overall tendency to attend to the stimulus cues and to the tendency to attend to the cues of the relevant dimensions. Two measures of relevant attending were used--relevant observing per trial and percentage relevant observing per trial. The latter measure represents the distribution of observing over the two dimensions independent of individual differences in the number of total observing responses. However, percentage relevant observing per trial does not indicate what the absolute number of relevant observing responses is, but rather how many relevant observing responses compared to irrelevant observing responses are being made. For example, verbalization is expected to increase the number of

observing responses to both dimensions, so that it would be expected to increase the <u>relevant observing per trial</u> but not the <u>percentage relevant observing per trial</u>.

One measure of total observing responses used was <u>total observing per trial</u>, that is the absolute number of tactual observing responses to both relevant and irrelevant dimensions. <u>Couplings per trial</u> was another measure of total observing examined. It seems that in a discrimination problem the amount of comparisons a subject makes between stimuli could be a useful measure of selective attention. Moreover, couplings are a variable that have been used before successfully in visual problems (Vurpillot, 1968). The use of these variables was necessary in order to answer questions about overall increased observing.

The dependent measures just described were computed over the first ten trials of the post-shift task since transfer was expected to be most evident just after the shift. They were also computed over the first ten trials of the pre-shift since verbalization treatments were being administered during the first ten pre-shift trials. The observing responses per trial over the total trials were also calculated in order to provide information about the amount of observing throughout the pre- and post-shift tasks.

<u>Scoring</u>. The tactual observing responses of each subject were recorded on videotape and scored later by the experimenter. The procedure used was to assign a number to

the different categories of observing responses made by the subject so that a continuous record of observing for each trial was kept. The following four categories of tactual observing responses were scored for intra-dimensional and extradimensional shift training tasks and for all the shift tasks:

(a) Left form response.

(b) Left texture response.

(c) Right form response.

(d) Right texture response.

The following four categories of tactual observing were scored for the training task of the control shift:

(a) Left size response.

(b) Left number response.

(c) Right size response.

(d) Right number response.

The scorer used the following criteria for classifying responses as form, texture, size, number responses, or couplings.

(1) Form responses. All responses where the subject framed the form of the stimulus with his hand were scored as form responses. The most common form response was to cup the hand over the stimulus. Another fairly frequent type of form response was to lie the hand flat over the top surface of the stimulus with the lower part of the fingers (nearest the palm) on the top of the stimulus (if the

finger tips touched the surface, this response was not categorized as a form response). Sometimes subjects made form responses by tracing the edges of the stimulus with their fingers, but this was less frequent.

(2) Texture responses. All responses where subjects touched or stroked the texture on the upper surface of the stimulus with their finger-tips were classified as texture responses.

(3) Size responses. Responses where subjects grasped the cylindrical shape around the side, cupped their hands over the top, or spanned the height of the stimulus with thumb and forefinger were classified as size responses. Overt responses to size such as those just described appeared to be an under-estimate of the observing of size, since simply raising or lowering the hand from one stimulus to the other (to make number responses for example) provided proprioreceptive information about the size of the stimuli to the subject.

(4) Number responses. Responses where subjects touched the bumps on the top of the stimuli with their finger-tips were designated as number responses.

(5) Couplings. A shift from a cue on the right stimulus to a cue on the left stimulus, or from a cue on the right stimulus to the left stimulus was designated a coupling.

Continuity of Responses. When subjects shifted from

form to texture or from the left to the right stimulus in their tactual observing, there was little difficulty for the scorer in classifying responses. However, it was fairly frequent for subjects to make prolonged tactual observing responses to one cue on a particular dimension. In other words responding was continuous rather than discrete. For example, a subject might stroke the right texture for 10 to 15 seconds while another subject might give the right texture a momentary touch. It seemed reasonable to try to distinguish the momentary touch from the continuous responding since the former constituted a smaller amount of observing than the latter. The experimenter, therefore, assigned a number (representing the category of response being made) to the observing responses at approximately every three seconds except when there was a shift to observing another cue, at which time another number was assigned.

Reliability of Measurement. Percentage of inter-scorer and intra-scorer agreements were used to assess the reliability of the scoring procedure. Inter-scorer reliability was tested by using one other scorer for four subjects. Intra-scorer reliability was measured by the regular scorer scoring the records of five subjects on two occasions separated by three weeks.

The independent scorer was given five hours of training by the regular scorer. This mainly involved

viewing the videotape together, scoring a number of trials without looking at each other's scoring, comparing the scoring and replaying the videotape until agreement had been reached over any discrepancies between the scoring methods and criteria. After he was trained, the independent scorer viewed videotapes of four different subjects and classified the observing responses of different subjects on three separate occasions, each separated by a week.

The reliability was calculated on the basis of percentage agreement between the number of relevant observing responses, number of total observing responses, and number of couplings recorded on the two scoring occasions. These measures were made over the first ten trials, criterion trials and the total trials since these were the basis for the dependent measures used in analysis. The relative number of observing responses recorded by judge 1 and judge 2 were expressed as a percentage with the largest number forming the denominator as follows:

$$\begin{array}{l}\text{\% Agreement on}\\ \text{Rel. Obs. for}\\ \text{1st 10 trials}\end{array} = \frac{\text{No. of Rel. Obs. R's for 1st 10 trials - Judge 1}}{\text{No. of Rel. Obs. R's for 1st 10 trials - Judge 2}} \times 100$$

Reliability indices for inter-scorer and intra-scorer agreement are reported in Tables 2 and 3 (Appendix C). There was virtually no disagreement on couplings--the mean inter-scorer agreement being 99.6 percent and the mean intra-scorer agreement being 100.0 percent. The mean

inter-scorer agreement for relevant observing was 91.5 percent and for total observing was 93.5 percent. The intra-scorer agreement for relevant and total observing was a little higher than the inter-scorer agreement. The reliability figures seem to suggest both that the method of scoring is able to be used consistently by one scorer and that other scorers may be trained to use the same method, since there was satisfactory consistency between and within scorers.

CHAPTER VI

RESULTS

The results of the present study are presented in this chapter in four sections, each of which deals with the data pertaining to each of the four sets of hypotheses in the study. The results are discussed in the following chapter. The analyses which were performed, as a routine check, on the extraneous variables of sex, dimension and training versus the experimental variables of shift and verbalization, are presented in this chapter in relation only to those hypotheses where relevant and significant interactions were observed.

No significant differences were found between experimental groups on one dependent variable, namely couplings per trial, throughout the study. In order to avoid needless repetition, the failure of couplings to show differences is stated here and is not repeated under the findings of each hypothesis.

One finding which is pertinent to all hypotheses, since it indicates a relationship between tactual observing and learning rate, was that post-shift trials to criterion was significantly negatively correlated with post-shift percentage relevant observing per trial over the first ten trials ($r = -0.52$, $p < 0.01$) and the total trials ($r = -0.40$, $p < 0.01$) and with relevant observing per trial over the

total trials ($r = -0.31$, $p < 0.05$).

While cell means for the treatment groups are reported for the principal analyses of the study, figures representing the same information will commonly be presented to facilitate conceptualization of the similarities, differences and relationships among the treatment groups.

Hypothesis 1

The first hypothesis predicted that verbalization treatments would have the effect of decreasing the number of trials to criterion and increasing the number of observing responses during the pre-shift task.

Trials to Criterion. The results of the analysis of variance for Verbalization treatment by Sex on pre-shift trials to criterion are shown in Table 4. Since the sex by verbalization interaction was statistically significant ($F[2,99]=4.56$, $p < 0.01$) Scheffé individual comparisons of means were computed. These comparisons indicated that:

(a) Males had significantly fewer trials to criterion than females under the assigned verbalization condition ($p < 0.05$).

(b) Females had significantly fewer trials to criterion than males in the no verbalization group ($p < 0.05$).

TABLE 4

MEANS AND ANALYSIS OF VARIANCE FOR SEX BY VERBALIZATION ON TRIALS TO CRITERION ON PRE-SHIFT TASK

(a) Mean pre-shift trials to criterion

Verbalization Groups	Sex		Verb. Means
	Males	Females	
Spontaneous Verbalization	32.07	30.86	31.45
Assigned Verbalization	27.82	39.70	33.76
No Verbalization	35.60	24.33	29.95
Sex Means	31.83	31.63	31.73

(b) Analysis of Variance

Source	df	MS	F	P
A (Verb)	2	130.31	0.495	0.610
B (Sex)	1	1.06	0.004	0.949
AB (Interaction)	2	1198.34	4.556	0.013
Error	99	263.04		

(c) There was no statistically significant difference between the means of males in the three different verbalization groups, but females had significantly fewer trials to criterion under the no verbalization conditions than under the assigned verbalization condition.

Figure 5 represents the disordinal sex by verbalization interaction, and indicates that males learned faster than females in the assigned verbalization group and females learned faster than males in the no verbalization group. The performance of both males and females in the spontaneous verbalization group was very similar.

Observing Responses over Total Trials. Tables 5 and 6 show, respectively, that there was a significant effect of verbalization on relevant observing per trial ($F[2,99]= 5.11$, $p < 0.01$), and on total observing per trial ($F[2,99]=9.27$, $p < 0.01$) over the total pre-shift trials. Scheffé comparisons between the verbalization treatment groups indicated that:

(a) The spontaneous verbalization group had significantly more relevant observing per trial than the no verbalization group ($p < 0.01$).

(b) The assigned verbalization group did not differ significantly from the spontaneous verbalization group or from the no verbalization group in relevant observing per trial.

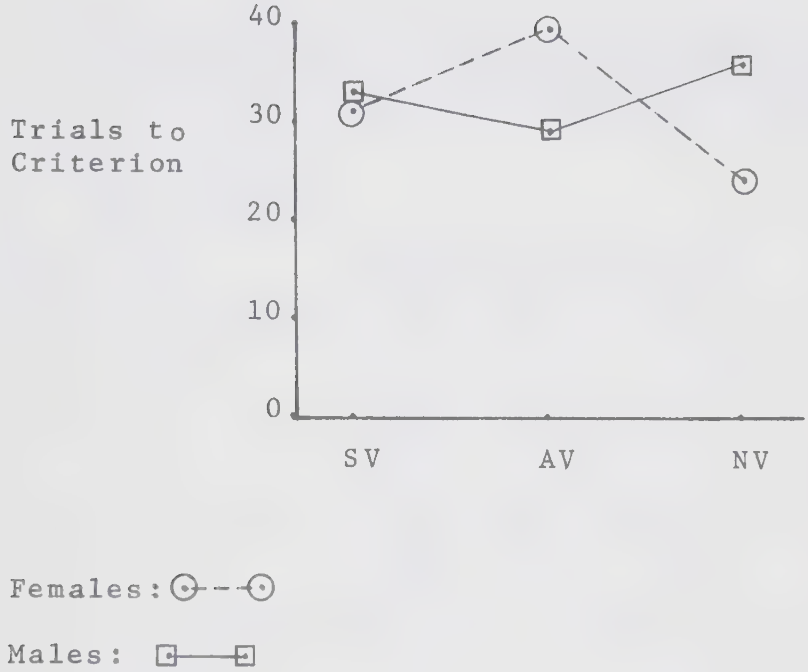


FIGURE 5

PRE-SHIFT TRIALS TO CRITERION FOR MALES AND FEMALES IN DIFFERENT VERBALIZATION GROUPS

TABLE 5

MEANS AND ANALYSIS OF VARIANCE FOR RELEVANT OBSERVING PER TRIAL OVER TOTAL PRE-SHIFT TRIALS

(a) Mean RO over Total Trials

Shift Gps	Verbalization Groups			Shift Means
	SV	AV	NV	
IDS	4.21	3.71	3.06	3.66
EDS	3.42	3.35	1.98	2.92
CS	3.16	2.28	2.23	2.56
Verb. Means	3.60	3.11	2.42	3.04

(b) Summary of Analysis of Variance

Source	df	MS	F	P
A (Shift)	2	11.39	4.63	0.011
B (Verb.)	2	12.56	5.11	0.007
AB (Interaction)	4	1.33	0.53	0.714
Error	99	2.46		

TABLE 6

MEANS AND ANALYSIS OF VARIANCE FOR TOTAL OBSERVING PER TRIAL OVER TOTAL PRE-SHIFT TRIALS

(a) Mean TO over Total Trials

Shift Gps	SV	AV	NV	Shift Means
IDS	6.77	6.91	5.23	6.30
EDS	6.77	6.52	3.39	5.56
CS	6.16	5.76	3.95	4.19
Verb. Means	6.57	6.39	4.19	5.72

(b) Summary of Analysis of Variance

Source	df	MS	F	P
A (Shift)	2	9.91	1.46	0.238
B (Verb.)	2	63.14	9.27	0.000
AB (Interaction)	4	3.19	0.46	0.765
Error	99	6.81		

(c) The spontaneous verbalization group had significantly more _total observing per trial_ than the no verbalization group ($p < 0.01$).

(d) The assigned verbalization group had significantly more _total observing per trial_ than the no verbalization group ($p < 0.01$).

(e) The assigned verbalization and the spontaneous verbalization group did not differ significantly in _total observing per trial_.

Figure 6 shows that the spontaneous and assigned verbalization conditions have the effect of increasing the number of observing responses made compared to the no verbalization condition.

Observing Responses over First Ten Trials. An analysis of sex by verbalization on the _total observing per trial_ over the first ten pre-shift trials revealed a significant interaction ($F[2,102]=3.51$, $p < 0.01$) as is shown in Table 7. Scheffé comparisons of the individual means for sex and verbalization groups revealed that:

(a) Males showed significantly less _total observing per trial_ than did females in the assigned verbalization group ($p < 0.05$).

(b) Males in the spontaneous and assigned verbalization groups showed significantly more _total observing per trial_ than males in the no verbalization group ($p < 0.01$, $p < 0.01$).

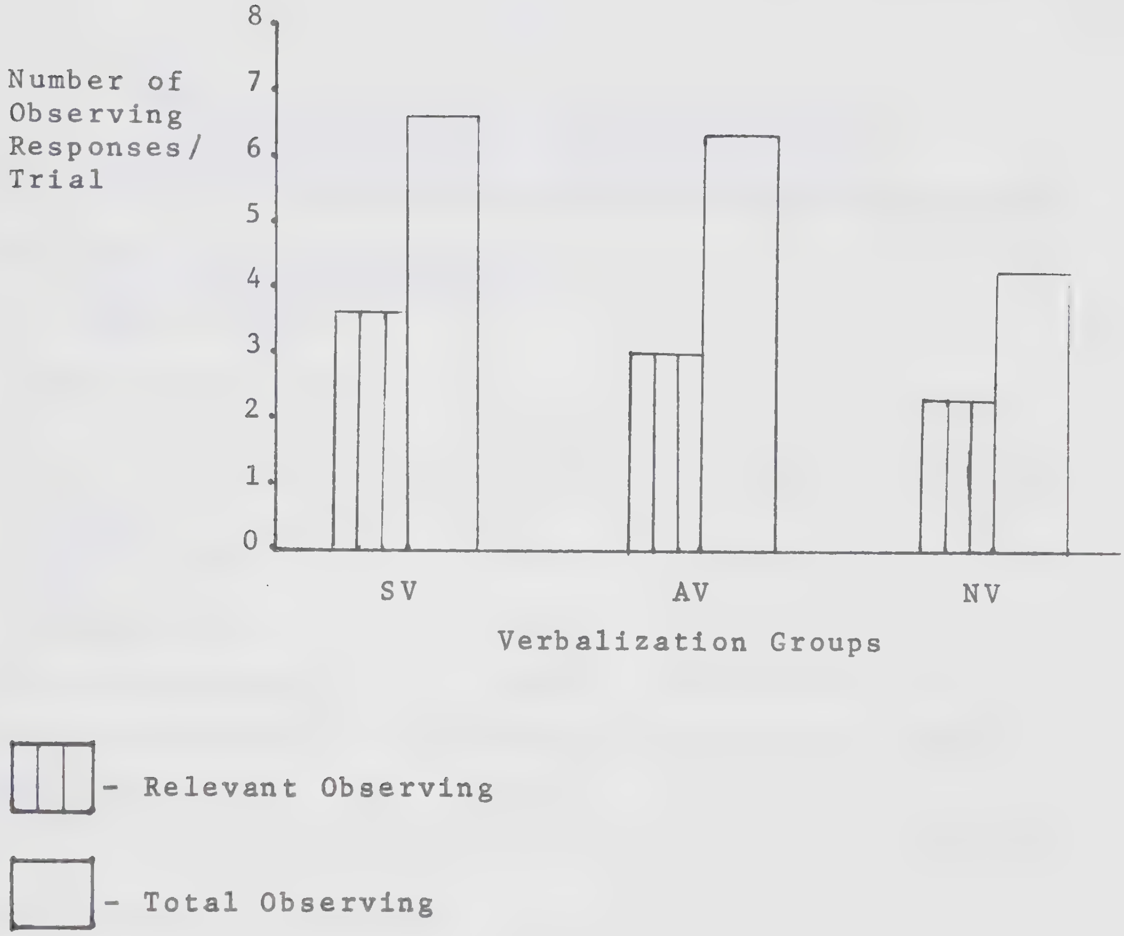


FIGURE 6

NUMBER OF RELEVANT AND TOTAL OBSERVING RESPONSES PER TRIAL FOR DIFFERENT VERBALIZATION GROUPS OVER TOTAL TRIALS

TABLE 7

MEANS AND ANALYSIS OF VARIANCE FOR SEX BY VERBALIZATION ON FIRST TEN PRE-SHIFT TRIALS FOR TOTAL OBSERVING PER TRIAL

(a) Mean total observing per trial over first ten pre-shift trials.

Verbalization Groups	Sex: Males	Sex: Females	Verb. Means
Spontaneous verbalization	9.10	8.00	8.55
Assigned verbalization	7.19	9.47	8.33
No verbalization	4.39	5.71	5.05
Sex means	6.89	7.71	7.31

(b) Analysis of variance

Source	df	MS	F	P
A (Verb)	2	132.81	16.84	0.000
B (Sex)	1	17.87	2.27	0.135
AB (Interaction)	2	27.71	3.51	0.033
Error	102	7.89		

(c) Females in the spontaneous and assigned verbalization groups showed significantly more total observing per trial than females in the no verbalization group ($p < 0.01$, $p < 0.01$).

Figure 7 illustrates the sex interaction with verbalization on total observing per trial over the first ten pre-shift trials. It can be seen that boys observe less than girls under all verbalization conditions except the spontaneous verbalization condition. The data, however, support the prediction that spontaneous and assigned verbalization groups observe more than the no verbalization group.

Summary of Findings for Hypothesis 1. There was no main effect of verbalization on trials to criterion, but a disordinal interaction between sex and verbalization was found. Girls learned the training task faster than boys when they were not given instructions to verbalize the cues, while boys learned the task faster than girls when they were assigned verbal labels for cues. Hypothesis 1.1, then, was not confirmed since there was no overall effect of verbalization on trials to criterion. In fact it was contradicted by the finding that girls learned faster under the no verbalization condition than under the assigned verbalization condition.

Significant main effects of verbalization on relevant observing per trial and total observing per trial

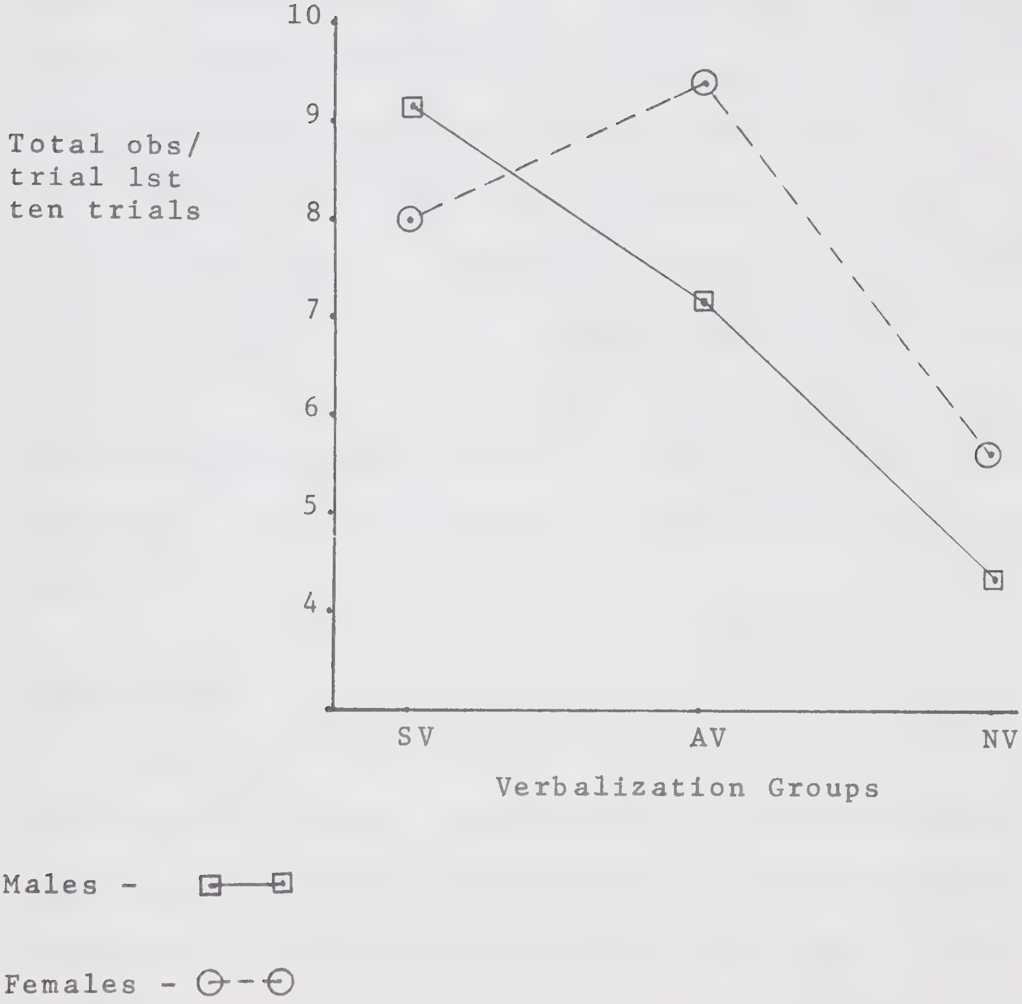


FIGURE 7

TOTAL OBSERVING PER TRIAL OVER FIRST TEN PRE-SHIFT TRIALS FOR MALES AND FEMALES IN DIFFERENT VERBALIZATION GROUPS

over the total pre-shift trials were found. Both the spontaneous and assigned verbalization conditions had the effect of increasing the number of observing responses to both relevant and irrelevant dimensions, hence providing support for Hypothesis 1.2. A significant interaction between sex and verbalization treatment was found on <u>total observing per trial</u> over the first ten trials. Boys initially observed both dimensions less than girls in the assigned and no verbalization groups, but slightly more than girls in the spontaneous verbalization group. Both boys and girls in the spontaneous and assigned verbalization groups, however, made more initial observing responses than boys and girls in the no verbalization group.

<u>Hypothesis 2</u>

The second hypothesis predicted that, for the no verbalization group, there would be a more rapid rate of learning and a greater percentage of relevant observing responses for an intradimensional shift than for an extradimensional shift, with a control shift predicted to show an intermediate rate of learning and percentage of relevant observing responses. It was also predicted that for the spontaneous and assigned verbalization groups there would be a more rapid rate of learning and a greater percentage of relevant observing responses for an intra-dimensional shift than for an extradimensional shift and

for an intradimensional shift than for a control shift, but that the control shift and the extradimensional shift would have a similar rate of learning and percentage of relevant observing responses.

Trials to Criterion. Table 8 shows that there was a significant main effect ($F[2,99]=11.35$, $p < 0.01$) of shift on trials to criterion on the post-shift task, but no significant interaction between shift and verbalization. There were therefore no grounds for treating the different verbalization groups differently with respect to the effect of shift condition, and Scheffé individual comparisons of shift means were carried out. These comparisons revealed that:

(a) The intradimensional shift group had significantly fewer trials to criterion than the extradimensional shift group ($p < 0.01$).

(b) The control shift group had significantly fewer trials to criterion than the extradimensional shift group ($p < 0.01$).

(c) There was no statistically significant difference between the means of the intradimensional and control shift groups on trials to criterion.

Observing Responses over the First Ten Trials. It can be seen from Table 9 that there was a significant main effect of shift group on percentage relevant observing per

TABLE 8

MEANS AND ANALYSIS OF VARIANCE FOR SHIFT AND VERBALIZATION ON POST-SHIFT TRIALS TO CRITERION

(a) Trials to criterion means

Shift Groups	Verbalization Groups SV	AV	NV	Shift Means
IDS	11.58	18.75	24.00	18.11
EDS	25.58	36.58	41.25	34.47
CS	24.33	25.83	20.75	23.64
Verb. Means	20.50	27.05	28.67	25.41

(b) Summary of Analysis of Variance

Source	df	MS	F	P
A (Shift)	2	2493.62	11.35	0.000
B (Verb.)	2	673.59	3.06	0.051
AB (Interaction)	4	325.45	1.51	0.206
Error	99	220.19		

TABLE 9

MEANS AND ANALYSIS OF VARIANCE FOR PERCENTAGE RELEVANT OBSERVING ON FIRST TEN POST-SHIFT TRIALS

(a) Mean percentage relevant observing on first ten post-shift trials

Shift Groups	Verbalization Groups			Shift Means
	SV	AV	NV	
IDS	58.33	62.00	71.41	63.91
EDS	45.25	43.92	39.17	42.78
CS	54.00	58.67	57.92	56.86
Verb. Means	52.52	54.85	56.16	54.32

(b) Summary of Analysis of Variance

Source	df	MS	F	P
A (Shift)	2	4169.83	12.51	0.000
B (Verb.)	2	122.34	1.34	0.694
AB (Interaction)	4	311.13	0.93	0.449
Error	99	333.34		

trial over the first ten post-shift trials ($F[2,99]=12.51$, $p < 0.01$) but no significant interaction between shift and verbalization. There were no significant effects of shift on the absolute number of relevant observing responses. Since the shift groups behaved similarly regardless of verbalization treatment, Scheffé comparisons of the shift means were performed. These individual comparisons revealed that:

(a) The intradimensional shift group had significantly more percentage relevant observing per trial than the extradimensional shift group ($p < 0.01$).

(b) The extradimensional shift group had significantly less percentage relevant observing per trial than the control shift group ($p < 0.01$).

(c) There was no statistically significant difference between the means of the control shift group and the intradimensional shift group on percentage relevant observing per trial.

Figure 8 illustrates the decreasing rate of learning from the intradimensional shift to the control shift to the extradimensional shift and the decreasing relative amount of observing the relevant dimension from the intradimensional shift to the control shift to the extradimensional shift. In other words, the shift which was most rapidly learned, the intradimensional shift, also involved the most observing of the relevant dimension

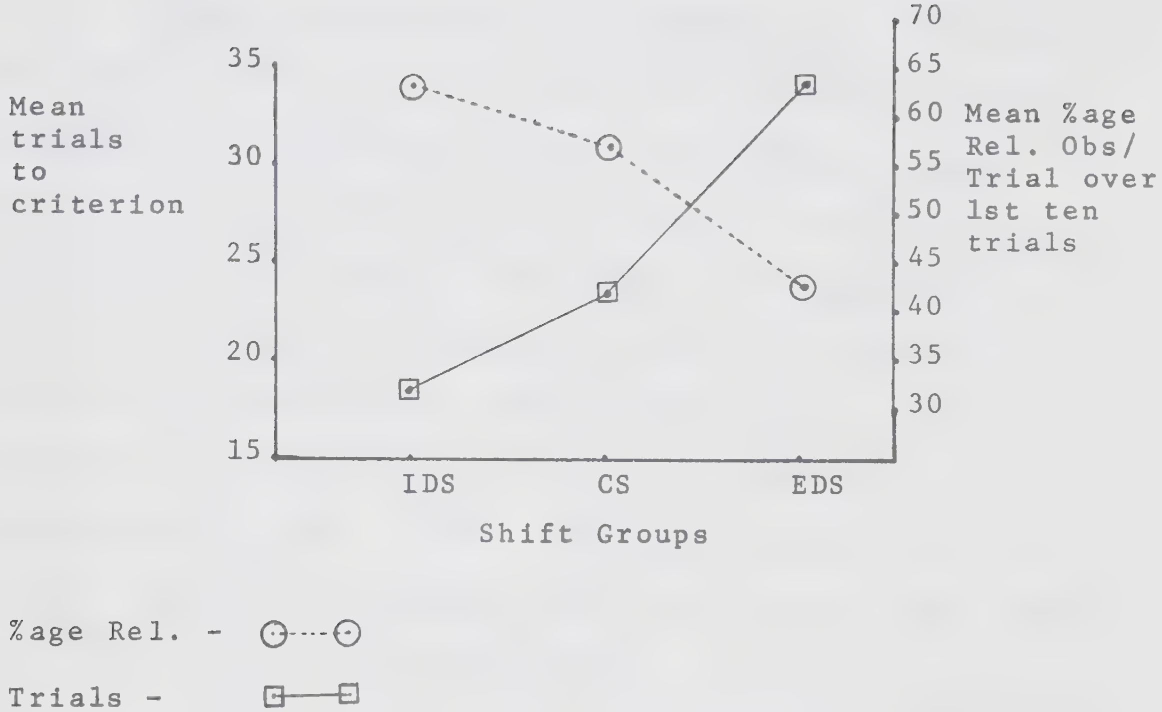


FIGURE 8

TRIALS TO CRITERION AND PERCENTAGE RELEVANT OBSERVING PER TRIAL OVER THE FIRST TEN POST-SHIFT TRIALS FOR THE THREE SHIFT GROUPS

compared to the irrelevant dimension in the immediate post-shift period, and vice versa for the extradimensional shift.

Summary of Findings for Hypothesis 2. Since there were significant main effects of shift on both trials to criterion and percentage relevant observing per trial, but no significant interaction between shift and verbalization, it was concluded that the prediction of different effects of shift for the no verbalization group than for the spontaneous and assigned verbalization groups was not sustained. The influence of shift was the same for all verbalization groups. When collapsing over verbalization groups, the intradimensional shift was learned most rapidly, the control shift at an intermediate rate and the extradimensional shift most slowly. Hypothesis 2.1, then, was confirmed except that the difference between the control shift and extradimensional shift mean trials to criterion was not statistically significant. Hypothesis 2.2 was confirmed insofar as intradimensional shift learning was found to be faster than extradimensional shift learning, however the expected difference between the control shift and the intradimensional shift was not statistically significant and an unpredicted difference between the extradimensional shift and the control shift was found.

The intradimensional shift group showed the greatest mean percentage relevant observing per trial, the

control shift an intermediate amount and the extradimensional shift the smallest amount. Hypothesis 2.3 was confirmed except that there was no statistically significant difference between the control shift and the intradimensional shift and there was no effect of shift on _relevant observing per trial._ Hypothesis 2.4 was confirmed insofar as there was found to be a greater _percentage relevant observing per trial_ for the intradimensional shift than for the extradimensional shift, but the expected difference between the control shift and the intradimensional shift did not reach statistical significance and there was an unpredicted difference between the extradimensional shift and the control shift. Hypothesis 2.4 was not confirmed in the prediction that there would be an effect of shift on the _relevant observing per trial_.

Hypothesis 3

The third hypothesis predicted that there would be no difference in either rate of learning or initial observing responses after shift, for different verbalization groups in a control shift, but that for extradimensional and intradimensional shifts, the spontaneous and assigned verbalization groups would both learn faster and observe more than the no verbalization group.

Trials to Criterion. It can be seen from Table 8

that there was no significant interaction effect of shift and verbalization but that there was a marginally significant main effect of verbalization on trials to criterion ($F[2,99]=3.06$, $p=0.051$). Hence it was not possible to treat the control, extradimensional, and intradimensional shifts as different with respect to verbalization groups. However, Figure 9 indicates that the pattern of means for trials to criterion within the control shift does appear as predicted although this difference was not in itself great enough to create a significant interaction effect. It can be seen from this figure that subjects in the extradimensional and intradimensional shifts learned more rapidly when given either spontaneous or assigned verbalization conditions but that subjects in the control shift learned at similar rates regardless of the verbalization condition which they had been given. Scheffé tests on the verbalization means were performed and the comparisons indicated that there were no statistically significant differences between the spontaneous, assigned or no verbalization groups on post-shift trials to criterion, although the difference between the spontaneous and no verbalization groups approached significance ($p=0.07$).

Observing Responses over the First Ten Trials. It can be seen from Tables 10 and 11 that there were significant main effects of verbalization on relevant observing per trial ($F[2,99]=8.73$, $p < 0.01$) and on total observing

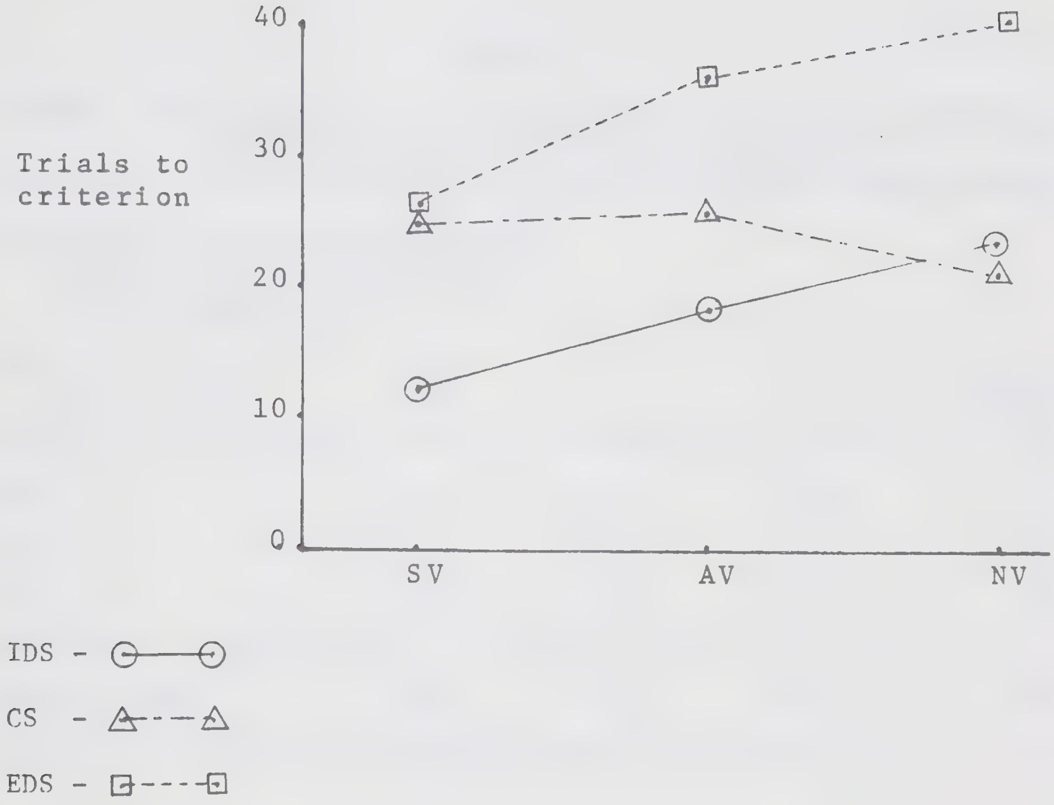


FIGURE 9

MEANS FOR SHIFT AND VERBALIZATION GROUPS ON POST-SHIFT TRIALS TO CRITERION

TABLE 10

MEANS AND ANALYSIS OF VARIANCE FOR RELEVANT OBSERVING OVER FIRST TEN POST-SHIFT TRIALS

(a) Mean relevant observing per trial for first ten post-shift trials

Shift Groups	SV	AV	NV	Shift Means
IDS	3.25	2.88	2.47	2.87
EDS	3.59	3.17	1.38	2.71
CS	3.32	3.32	2.11	2.92
Verb. Means	3.39	3.13	1.99	2.83

(b) Summary of Analysis of Variance

Source	df	MS	F	P
A (Shift)	2	0.41	0.18	0.836
B (Verb.)	2	20.01	8.73	0.000
AB (Interaction)	4	2.12	0.92	0.455
Error	103	2.29		

TABLE 11

MEANS AND ANALYSIS OF VARIANCE FOR TOTAL OBSERVING FOR FIRST TEN POST-SHIFT TRIALS

(a) Mean total observing per trial for 1st ten trials post-shift

Shift Groups	SV	AV	NV	Shift Means
IDS	5.83	4.90	4.06	4.93
EDS	7.36	6.79	3.45	5.87
CS	6.16	5.63	3.60	5.13
Verb. Means	6.45	5.77	3.70	5.31

(b) Summary of Analysis of Variance

Source	df	MS	F	P
A (Shift)	2	8.81	1.43	0.243
B (Verb.)	2	7.36	11.99	0.000
AB (Interaction)	4	5.57	0.90	0.465
Error		6.14		

per trial ($F[2,99]=11.99$, $p < 0.01$) over the first ten post-shift trials, but that there were no significant interactions between shift and verbalization. It was concluded, therefore, that the number of observing responses immediately after the shift for the three shift groups were influenced in similar ways by verbalization treatments. Scheffé comparisons revealed that over the first ten trials:

(a) The spontaneous verbalization group had significantly more relevant observing per trial than the no verbalization group ($p < 0.01$).

(b) The assigned verbalization group had significantly more relevant observing per trial than the no verbalization group ($p < 0.01$).

(c) The spontaneous verbalization group had significantly more total observing per trial than the no verbalization group ($p < 0.01$).

(d) The assigned verbalization group had significantly more total observing per trial than the no verbalization group ($p < 0.01$).

Figure 10 illustrates that both the spontaneous and assigned verbalization groups produced a greater number of observing responses per trial than the no verbalization group. The spontaneous verbalization group had a tendency to produce even more observing than the assigned verbalization group but this difference is not statistically significant.

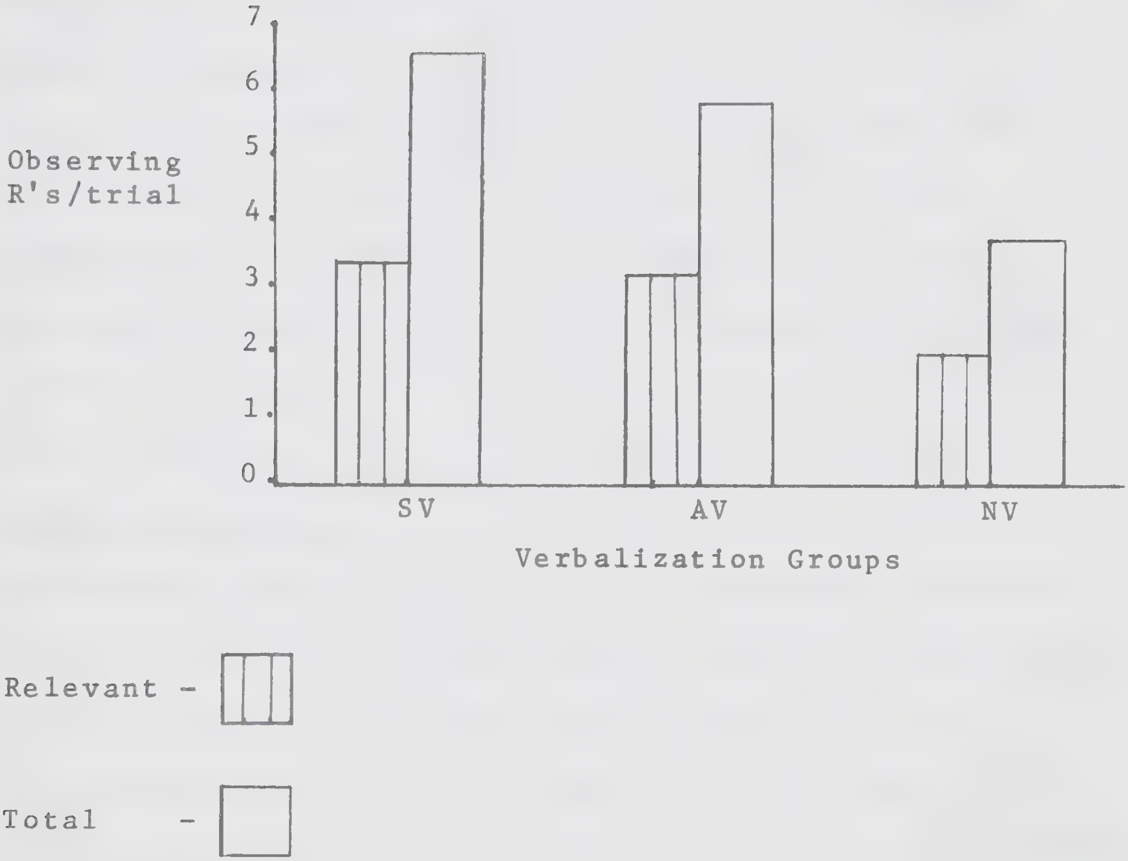


FIGURE 10

MEANS OF RELEVANT AND TOTAL OBSERVING RESPONSES PER TRIAL IN THE FIRST TEN POST-SHIFT TRIALS FOR DIFFERENT VERBALIZATION GROUPS

<u>Summary of Findings for Hypothesis 3.</u> The main effect of verbalization on <u>trials to criterion</u> was only marginally significant and Scheffé comparisons of verbalization means did not reveal any significant differences between the learning rates of the spontaneous, assigned and no verbalization groups. The differences, however, were in the direction of more rapid learning for the spontaneous and assigned verbalization groups than for the no verbalization group. Hypothesis 3.1, stating that there will be no significant difference in the rate of learning for verbalization groups on <u>trials to criterion</u> is therefore confirmed. Hypothesis 3.2 was not confirmed since spontaneous and assigned verbalization means on <u>trials to criterion</u> for the intradimensional and extra-dimensional shift groups were not significantly smaller than for the no verbalization group. However, the hypothesis is given limited support from the finding that the differences were in the predicted direction (spontaneous and assigned verbalization means less than no verbalization mean) although they were not significant.

Verbalization had a significant main effect on <u>relevant</u> and <u>total observing per trial.</u> Spontaneous and assigned verbalization had the effect of increasing the number of observing responses to both relevant and irrelevant dimensions compared to no verbalization. Hence Hypothesis 3.3 which predicted no difference in number of observing responses for control shift subjects in the

verbalization treatment groups was not confirmed, but Hypothesis 3.4 which predicted a greater number of observing responses for intradimensional and extra-dimensional shift subjects in the verbalization treatment groups was confirmed.

Hypothesis 4

The fourth hypothesis predicted that verbalizers of the correct solution to pre- or post-shift tasks would have learned the training and the shift task more rapidly and would have made more observing responses on the training and shift task than non-verbalizers. It was also predicted that verbalization treatments compared to no verbalization would increase the number of solution verbalizers.

Trials to Criterion. There were no significant differences between the mean trials to criterion for the pre-shift task but there were significant differences between the verbalizers and non-verbalizers on post-shift trials to criterion ($F[2,105]=4.86$, $p=0.01$, (see Table 12). Scheffé comparisons revealed that:

(a) Verbalizers of both solutions (to pre- and post-shift tasks) had significantly fewer trials to criterion than non-verbalizers ($p < 0.05$).

(b) Verbalizers of one solution (to either pre- or post-shift task) had significantly more trials to criterion than verbalizers of both solutions ($p=0.01$).

TABLE 12

MEANS AND ANALYSIS OF VARIANCE FOR SOLUTION VERBALIZATION ON POST-SHIFT TRIALS TO CRITERION

(a) Means for Trials to Criterion

	Solution Verbalization			
	V(2)*	V(1)*	Non-V*	Total
Mean	17.62	29.13	27.46	25.41
N	29	38	41	108

(b) Summary of Analysis of Variance

Source	df	MS	F	P
Groups	2	1229.37	4.86	0.010
Error	105	252.91		

*V(2) - Verbalizers of solutions to both pre- and post-shift problems.
*V(1) - Verbalizers of solutions to either the pre- or post-shift problem.
*Non-V- Verbalizers of neither solution.

Figure 11 illustrates the more rapid rate of learning for verbalizers of both solutions than for verbalizers of one solution and non-verbalizers.

Observing Responses over First Ten and Total Trials. There were no significant differences between solution verbalizing groups on any dependent measures of tactual observing for the training task. On the post-shift task there were no significant differences between solution verbalizers on total observing per trial, but the means of solution verbalizers on relevant observing per trial in the first ten trials were significantly different ($F[2,105]= 3.21$, $p < 0.05$). The differences between the means of solution verbalizers approached significance for relevant observing per trial over total trials ($F[2,105]=3.00$, $p < 0.10$), (see Table 14). Scheffé comparisons of solution verbalizing means revealed that:

(a) Verbalizers of one solution had a significantly greater mean relevant observing per trial on the first ten post-shift trials than non-verbalizers.

(b) No significant differences between the means of verbalizers of one solution, verbalizers of both solutions and non-verbalizers occurred on relevant observing per trial over the total post-shift trials.

Verbalizers appear to give more relevant observing responses per trial than non-verbalizers, as can be observed from Figure 12.

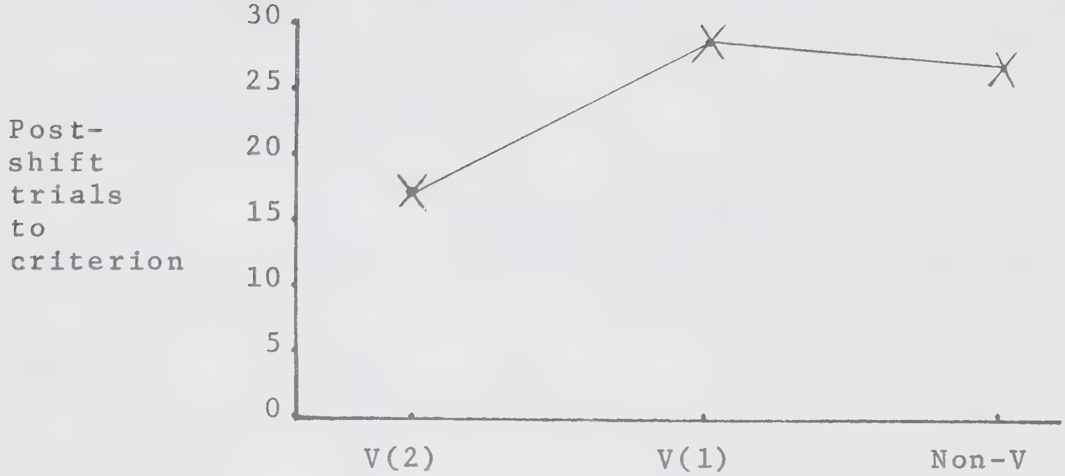


FIGURE 11

MEAN POST-SHIFT TRIALS TO CRITERION FOR VERBALIZERS OF BOTH SOLUTIONS, VERBALIZERS OF ONE SOLUTION AND NON-VERBALIZERS

TABLE 13

MEANS AND ANALYSIS OF VARIANCE FOR SOLUTION VERBALIZERS ON RELEVANT OBSERVING PER TRIAL

(a) Means for relevant observing on first ten and total trials.

	Solution Verbalization			
	V(2)	V(1)	Non-V	Total
First ten trials	3.01	3.21	2.35	2.83
Total trials	2.94	2.76	2.21	2.59

(b) Summary of Analysis of Variance for first ten trials

Source	df	MS	F	P
Groups	2	7.97	3.21	0.044
Error	105	2.48		

(c) Summary of Analysis of Variance for total trials

Source	df	MS	F	P
Groups	2	5.35	3.00	0.053
Error	105	1.79		

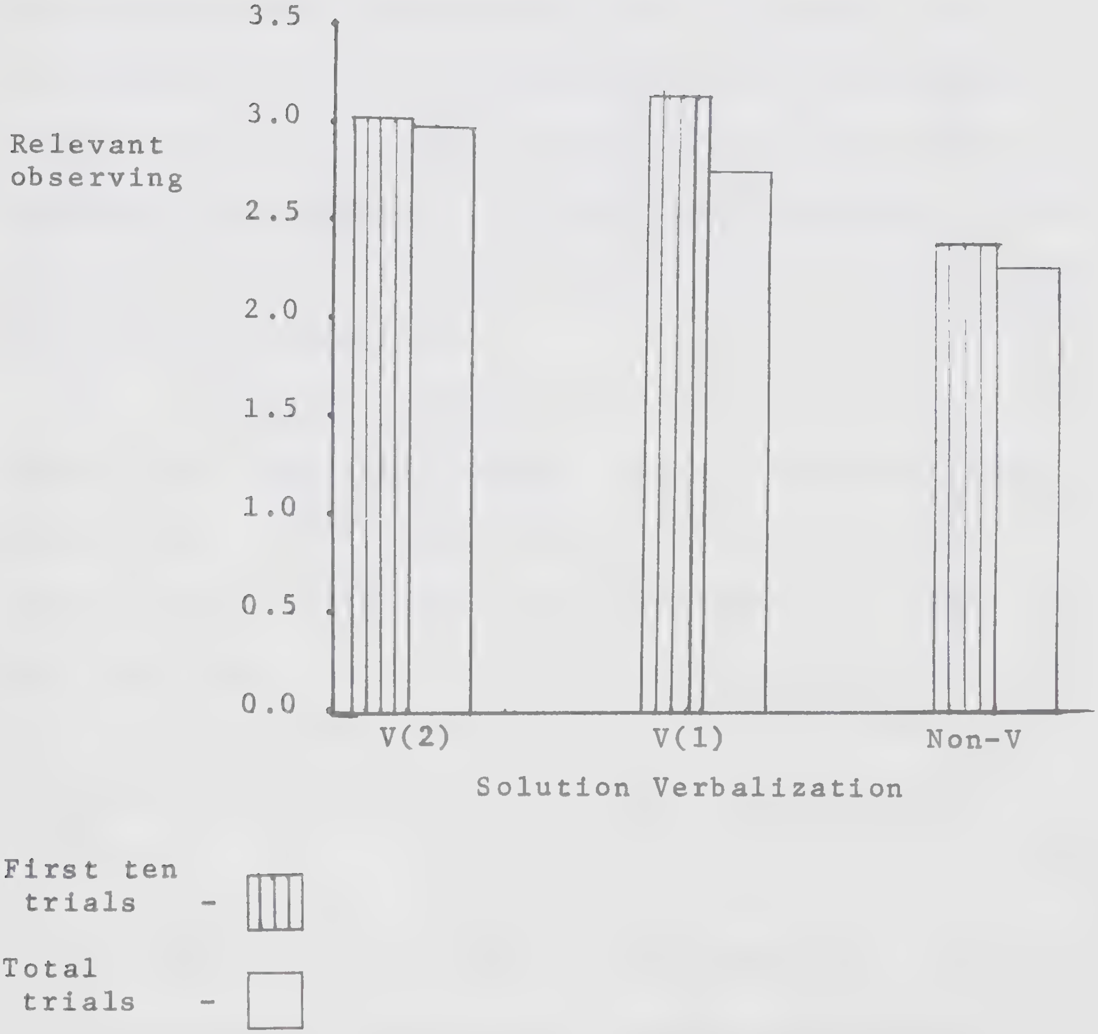


FIGURE 12

MEANS OF RELEVANT OBSERVING RESPONSES WITHIN POST-SHIFT TRIALS FOR DIFFERENT SOLUTION VERBALIZING GROUPS

A test of the independence of verbalization treatment and solution verbalization indicated that the two were not independent (X^2=7.69, $p < 0.05$), (see Table 14). There were a greater number of verbalizers in the spontaneous verbalization group and a smaller number of verbalizers in the no verbalization group than would be expected if verbalization treatment were independent of solution verbalization. The observed frequencies for the assigned verbalization group do not differ markedly from the expected frequencies.

In order to determine whether girls were better verbalizers (one might assume, verbal mediators) than boys, a test of the independence of sex and solution verbalization was carried out (see Table 15). This test revealed that sex was not independent of solution verbalization (X^2=11.52, $p < 0.01$) and that there were a greater number of girls than boys who verbalized solutions.

Summary of Findings for Hypothesis 4. There were no differences in the pre-shift trials to criterion of the solution verbalizing groups, but it was found that on post-shift trials the verbalizers had learned the task faster than non-verbalizers. In particular, verbalizers of both solutions learned the task faster than non-verbalizers and verbalizers of one solution. Hence Hypothesis 4.1 is confirmed for post-shift but not for pre-shift trials to

TABLE 14

CONTINGENCY TABLE SHOWING RELATIONSHIP BETWEEN VERBALIZATION TREATMENT AND VERBALIZATION OF CORRECT SOLUTION

	Solution Verbalization				
	V(1) & V(2)		Non-V		Total
Verb. Treat.	$f_{obs.}$	$f_{exp.}$	$f_{obs.}$	$f_{exp.}$	
SV	28	(22.11)	8	(13.85)	36
AV	23	(22.11)	13	(13.85)	36
NV	17	(22.11)	17	(13.85)	36
Total	68		40		108

Chi square = 7.69 ($p < 0.05$).

TABLE 15

CONTINGENCY TABLE SHOWING RELATIONSHIP BETWEEN SEX AND SOLUTION VERBALIZATION

	Solution Verbalization				
	V(1) & V(2)		Non-V		Total
Sex	$f_{obs.}$	$f_{exp.}$	$f_{obs.}$	$f_{exp.}$	
Males	25	(33.33)	28	(19.64)	53
Females	43	(33.33)	12	(19.64)	55
Total	68		40		108

Chi square = 11.52 ($p < 0.01$).

criterion.

No differences in observing responses between the solution verbalizing groups were found on pre-shift trials to criterion, but verbalizers of one solution observed the relevant dimension more in the first ten post-shift trials than non-verbalizers. Hypothesis 4.2, then, is not confirmed for the training task but receives some confirmation on the shift task for relevant observing per trial (over the first ten trials) but not for total observing per trial.

Verbalization treatment was found to affect solution verbalizing. In particular, spontaneous verbalization led to a greater number of correct verbal solutions while no verbalization resulted in fewer correct verbal solutions. Hypothesis 4.3, therefore, was confirmed insofar as a greater number of verbalizers were found in the spontaneous verbalization group than in the no verbalization group, but the assigned verbalization treatment did not affect solution verbalization.

CHAPTER VII

DISCUSSION, IMPLICATIONS AND SUMMARY

Discussion

Hypothesis 1. The performance of children on the training task of this study does not give unqualified support for the argument that discrimination learning is facilitated by instructions to verbalize stimulus cues. Girls were even actually hampered in reaching a solution to the training task when they were assigned verbal labels, and they learned most rapidly when they did not name the relevant and irrelevant dimensions prior to making an instrumental choice response. Boys did learn the training task slightly (but not significantly) faster when they verbalized assigned labels than when they were not required to verbalize.

A possible explanation for these results may lie in developmental differences between boys and girls. It has been consistently reported (Anastasi, 1958; Terman & Tyler, 1954; Tyler, 1965) that girls reach physical and intellectual maturity more rapidly than boys. In particular, their verbal fluency and general language skills are generally found to be more advanced during the earlier years of schooling. One of the reasons for choosing grade one children for the present study was that they fall within the five to seven year old age range

(although at the upper limit) which is thought to be a stage when discrimination learning is facilitated by external instructions to verbalize (Luria, 1969; White, 1965). After this sensitive stage has been passed, it is argued that children are capable of providing their own inner verbalizations to mediate problem solution. It has also been found (White, 1965; Weir & Stevenson, 1959) that after the age of seven, discrimination learning performance actually declines to some degree. White (1965) suggests that this decline in discrimination learning performance with age may be due to the formation of complex hypotheses which interfere with the solution of simple problems.

It is possible that more of the boys in this study were at the transitional stage when verbal instructions tend to facilitate discrimination. Girls, on the other hand, having more facility with language, are more likely to have passed this phase and hence can be supposed to be capable of verbally mediating problem-solution without external instructions to verbalize. Some support for this proposition was provided by the finding that girls were better able to verbalize the correct solutions to the discrimination problems than boys, which suggests that girls had the appropriate verbal mediation for the problem more often than boys. When girls were in a verbalization treatment group where they were required to verbalize overtly, they may have been encouraged to formulate complex

hypotheses which hindered rather than facilitated problem-solution.

The particular paradigm and verbalization treatments used in this study (chosen because the focus of interest in the study was in shift behavior) may have limited the potentiality of the study for revealing facts about discrimination learning in a more general sense. One reason which has been suggested for the failure to find support for Hypothesis 1.1 might be the tendency of some subjects to form over-complex hypotheses. Another possible basis for the failure of the first hypothesis can be found in the design of the study itself. The instructions to verbalize given in this study necessitated the observation of both relevant and irrelevant dimensions. It is possible that the necessity for building more complex mediational chains involving mediation to both relevant and irrelevant dimensions could have slowed down the acquisition of the correct instrumental choice response. In hind-sight, then, it seems that the outcomes of the treatments with respect to the first part of the first hypothesis might be expected to be equivocal. A modification of the design, to be discussed later, might clarify the problem.

The suggestion in the preceding discussion that verbalization treatments led to the observation of both relevant and irrelevant dimensions is in agreement with the findings for the observing responses during the

pre-shift task. Both types of verbalization treatment, compared with no verbalization, increased the tactual observing of subjects to both the relevant and irrelevant dimensions of the stimuli. Verbalization, then, in accord with Luria's views of the directive function of language, had a strong influence on the attentional behavior of subjects in this study. The data gave good reason for believing that mediating responses to both dimensions of the discriminative stimuli were established by verbalization during training. The verbalization treatments seemed to have the effect of reducing the extinction of irrelevant observing responses, a factor which could be expected to have considerable bearing on both pre- and post-shift learning.

The finding that boys initially observed less than girls in the assigned verbalization condition is interesting, considering that boys learned the training task faster than girls under the same condition. It is possible that the greater amount of observing but slower learning shown by girls in the assigned verbalization group supports the suggestion that assigned verbal labels encouraged girls to form over-complex hypotheses.

Hypothesis 2. The performance of children on the shift task of this study provides good support for the predictions of mediational theory. The shift which is believed to involve negative transfer of a mediational

chain, the extradimensional shift, was learned most slowly, while the shift which is said to involve positive transfer of a mediational chain, the intradimensional shift, was learned most rapidly. The control shift, in which there is thought to be no direct mediational transfer was learned at an intermediate rate, although the difference between the rate of control shift learning and intradimensional shift learning was not significantly different. The study also supports the proposition that at least some of the mediation which occurs in discrimination learning is related to attention. The relative amount of observing of the relevant dimension immediately after the shift was greatest for the intradimensional shift, intermediate for a control shift and least for an extradimensional shift, although the difference between the control shift and the intradimensional shift did not reach significance. It seems, therefore, that negative transfer of attentional mediation was occurring in an extradimensional shift and positive transfer of attentional mediation was occurring in an intradimensional shift. The fact that observing responses seem to be transferred in shift problems, along with the observed correlation between observing responses and speed of learning the shift problem, seem to lend support to the argument that some of the mediation occurring in discrimination learning is attentional in nature.

The control shift is included in shift studies as an

explicit test for the direction of mediational transfer (Shepp & Turrisi, 1967). Hence the finding that the rate of learning for a control shift is intermediate between that of an extradimensional shift and an intradimensional shift allows one to assume that the intradimensional shift involves positive mediational transfer, the extradimensional shift negative mediational transfer and the control shift no transfer. If, however, the control shift and the intradimensional shift are not significantly different (as in the present study), there are grounds for concluding either that positive transfer does not occur in the intradimensional shift or that positive transfer or some other type of facilitation does occur in a control shift. The view that a control shift is facilitated in a manner not shared by the intradimensional and extradimensional shifts is strengthened by Eimas's suggestion that a control shift may be speeded up by the appearance of novel dimensions, an inevitable characteristic of a control shift. The effect of novelty is argued to increase attention to the stimulus cues and hence increase the speed of learning. In the present study, nevertheless, the differences between the means of the shift groups were in the predicted direction (an intradimensional shift greater than an extradimensional shift and a control shift intermediate). It is possible that undue individual differences in the sample have inflated the error variance to such an extent that an actual

difference between the intradimensional and control shift in trials to criterion and percentage relevant observing was masked. Further studies with larger samples and more powerful statistical tests are clearly necessary to clarify this point.

The differential effect of shift for different verbalization groups which was predicted was not observed. Some possible reasons for this are examined under the discussion of hypothesis three.

Hypothesis 3. The finding that verbalization treatments facilitated shift performance is in accord with theories (Luria, 1969; Kendler, 1970) which suggest that language plays an important part in the strengthening of mediational chains. In the present study verbalization treatment necessitated verbalizing both dimensions which made it easier for subjects in the verbalization groups than for subjects in the no verbalization group to shift to the same dimension (an intradimensional shift) and also to a different dimension (an extradimensional shift). The fact that verbalization subjects observed both dimensions during pre-shift trials strengthens the argument that mediation relevant to both dimensions was being learned by subjects who verbalized. The writer has argued that a complex mediational chain involving mediation to both dimensions is established for verbalization subjects but not necessarily for no verbalization subjects, and the data

so far discussed tentatively supports this position. The findings for the control shift however are somewhat equivocal in the light they throw on this issue. The expected interaction between shift and verbalization was not found. It was predicted that the control shift would not be influenced by the verbalization treatments, whereas the extradimensional and intradimensional shifts would be facilitated by them. Although there was no significant shift by verbalization interaction, an examination of the means for trials to criterion (see Figure 9 , Chapter 6) suggests that the learning rates of the three different shift groups appeared to be somewhat differently affected by verbalization. For the control shift, the learning rates of the spontaneous, assigned and no verbalization groups were almost the same, while for the intradimensional and extradimensional shifts the two verbalization groups learned faster than the no verbalization group. Caution must be used in interpreting these apparent differences, since significant statistical differences were not present.

If verbalization facilitates learning in extra-dimensional, intradimensional and control shifts (as is suggested by the main effect of verbalization and absence of an interaction effect) one would have to argue that at least one of the effects of verbalization was to facilitate so-called indirect transfer or learning set. An effect of verbalization during training might be to produce a tendency

to mediate which continues into the shift task. If this were the case control shift learning should be facilitated. Unfortunately the data on trials to criterion are not helpful in resolving this question. On the one hand there was no significant interaction of shift by verbalization but on the other hand the means followed the predictions generated by the mediational chaining theory proposed in hypothesis three of this study (see preceding discussion). A further difficulty in reaching definite conclusions is that the individual verbalization means (collapsed over shift groups) were not significantly different, despite the fact that there was a significant main effect of verbalization on trials to criterion. In brief the findings of this study do suggest that verbalization facilitates shift learning but it is not possible to definitely state that it does so by establishing mediational chains during training which are utilized in shift. This is one possibility, but a second possibility is that verbalization leads to a general tendency for subjects to mediate during both training and shift problems, regardless of the specific dimensions involved.

The findings for observing responses are somewhat less equivocal than the findings for rates of learning. The effect of verbalization on observing responses in the post-shift trials immediately after shift was to increase the number of observing responses to both the relevant and

irrelevant dimensions. It would seem, therefore, that verbalization does direct attention, as has been argued by Luria. Verbalization, however, increased the number of relevant and irrelevant observing responses for all three shift groups. The fact that verbalization groups in the control shift observed more after the shift than the no verbalization group seems to indicate clearly that one of the effects of verbalization is to increase the non-specific transfer, or set to mediate, from a training task to a shift task. If the effect of verbalization is only to facilitate direct transfer of mediational chains to dimensions from the training to the shift task, one would not expect that a control shift group would show evidence of more mediating activity after the shift when verbalization during training had occurred. This is because a control shift is not believed to involve direct transfer of specific dimensional mediation. The informal observations of the experimenter that subjects in all shifts (including the control shift) who received verbalization treatment during training usually verbalized new labels for the cues of shift stimuli supports the interpretation that indirect transfer of mediational set was a result of verbalization treatment. The question of whether verbalization affects direct or indirect transfer or both, from training to shift, then, is not clearly answered by the present findings. A modification in design to be discussed later might illuminate the

manner in which verbalization facilities shift learning.

The performance of spontaneous and assigned verbalization groups on speed of learning and the various measures of tactual observing were not significantly different throughout the study. The tendency of the spontaneous verbalization group to learn the shift task slightly faster and observe the stimuli slightly more during pre- and post-shift tasks than the assigned verbalization group does, however, suggest the possibility that the use of the child's own words may be more efficient in facilitating the establishment of mediating and associated instrumental responses than the imposition of assigned labels. It would appear that the comparison of larger spontaneous and assigned verbalization groups might illuminate the question of which of these procedures is the most effective way to encourage mediational problem-solving.

One of the dependent tactual observing variables, namely couplings per trial, did not prove to be affected by verbalization treatments. The writer is unable to find a satisfactory explanation for the failure of this variable. It is possible that the effect of verbalization was to require subjects to examine and compare both dimensions in which case a more appropriate definition for a coupling would have been a comparison between individual cues rather than between stimuli.

Hypothesis 4. The finding that the ability of subjects to verbalize the correct solutions to the discrimination problems was related to the speed of shift learning, and to the number of relevant observing responses immediately after the shift, adds support to the view that attentional and verbal mediation are linked in discrimination learning problems. Solution verbalizers may be supposed to have learned verbal mediational chains appropriate to the problem and hence to be better able to perform mediational transfer problems. Moreover if verbal mediators also employ more attentional mediation there would seem to be a link between the two processes, possibly such that verbal and attentional responses and the associated response-produced cues exist concurrently on mediating chains leading to instrumental choice responses. The fact that there tended to be more verbalizers of the correct solution in the verbalization treatment groups suggests that the verbalization treatments themselves encouraged verbal mediation. Some caution must be used in interpreting the solution verbalization findings since they were not always clear-cut with respect to whether verbalizers of one or both solutions were faster shift learners and better attenders. The ability to verbalize both solutions seems to be contaminated with the ability to recall, a factor which also could effect discrimination learning. Verbalizers of both solutions were faster learners of the shift problem than non-verbalizers

and verbalizers of one solution were better observers of the relevant dimension after the shift than non-verbalizers.

In general, then, the study showed that transfer of selective attentional responses is involved in mediational problem-solving. The intradimensional shift is not only learned faster than the extradimensional shift but more attention is paid to the relevant dimension after shifting in the intradimensional shift than in the extradimensional shift. The effect of verbalization during training was to facilitate the learning of shift problems and to produce a greater overall tendency to observe the relevant and irrelevant dimensions. Verbalization treatments also tended to encourage verbal mediation as indicated by ability to correctly verbalize the solution to the discrimination problems.

Limitations. Before examining the wider implications of the present study it seems appropriate to point out some limitations which may restrict the generalizability of the findings. The identification of observing responses with selective attention has been criticized (Reese & Lipsitt, 1970) hence the use of tactual observing responses as measures of selective attention in the present study is subject to some question. The present writer, however, has argued that there is sufficient evidence to believe that tactual observing responses, while not the same thing as

selective attentional responses, are functionally related to them.

A second limitation of this study is the use of a tactual discrimination task. It would seem that the use of the tactual mode is somewhat unnatural for children at the grade one level.

A third, and in the writer's view most serious limitation of this study stems from the failure of the design to reveal the specific manner in which verbalization influences shift learning.

Finally, a number of findings which are either marginally significant or insignificant but in the predicted direction have been discussed. The inferences to be made from such findings are limited but it was felt that there was some merit in presenting them in a study which was to some degree exploratory, since the tentative nature of the findings might be rendered more definitive by further research into the problem.

Implications

Theoretical. There have been two major types of criticism of research dealing with the nature of mediation in discrimination learning. The first criticism is directed towards the use of a paradigm supposedly beset with theoretical flaws, used mainly by a group of researchers whose primary interest is in the verbal nature of mediation in discrimination learning, namely the reversal shift

paradigm. The second major criticism refers to the manner in which circularity has been manifest in the use of theoretical arguments inferring the nature of mediation from the way in which instrumental responses are learned. This criticism has primarily been directed against proponents of an attentional mediating mechanism in discrimination learning.

The present study has been an attempt to solve some of these problems and in addition examine whether it is possible that both verbal and attentional mediation are involved in discrimination learning. The use of a direct measure of observing responses in addition to a measure of speed of learning enabled the observation that attentional responses were indeed transferred from a training task to a shift task and appeared to mediate the acquisition of an instrumental response. Hence it can be concluded that at least one component of the mediation involved in discrimination learning was attentional in nature. Indeed the relationship between more rapid learning and a greater degree of observing appropriate cues provides some evidence to support Rydberg's (1966) proposition that tactual observing is an adequate measure of selective attention.

The question of whether verbal responses mediate in discrimination learning problems was also addressed in this study, using a paradigm (the total change design) appropriate for the investigation of mediational transfer. The observation that verbal mediation facilitated

intradimensional and extradimensional shifts, as well as the finding that verbal mediators (verbalizers of correct solution) learned the shift tasks more rapidly, is somewhat tentative support for Kendler and Kendler's (1962) argument that verbal mediational chains are transferred in shift tasks. Some doubt is generated by the lack of clarity over whether control shifts, in which no direct transfer of mediation is involved, were facilitated by verbalization or not. Verbal mediation does appear to be involved in discrimination shift learning since subjects who overtly verbalized stimulus cues learned faster. However, the effect of verbalization in the initial trials seemed to encourage subjects to mediate whatever stimulus dimensions they were presented with.

Luria's (1969) theory receives the strongest support from the findings of this study. The verbalization of labels for cues on the training task resulted in a greater amount of attention to the verbalized cues, hence supporting Luria's view that speech has a directive function on attention and discrimination learning. The wider implication of the findings for mediational theory is that verbal mediation is likely to be accompanied by attentional mediation. In other words, the fairly widespread view that _either_ verbal _or_ attentional mediation occurs in discrimination learning is not supported by the present study. Rather, it appears that both verbal and attentional

mediation are components of the process of discrimination learning.

Future Research. In order to make a stronger case for the importance of both attentional and verbal mediation in discrimination learning, several further steps in research are necessary. First, it would be desirable to replicate the present study using visual rather than tactual discrimination tasks, since the former are more commonly used in everyday discriminations. The use of visual problems would also allow a measure of selective attention to be employed, namely eye movements, which seem in some respects to be more closely related to central cognitive events. It would also be very relevant to examine Luria's notion of the effect of verbalization on orienting responses by looking at some measures of intensive attention under verbalization and no verbalization conditions during discrimination shift learning (e.g. pupillary responses, galvanic skin responses or heart-rates).

A further necessary step in research is to examine the performance of older children under circumstances similar to those which applied in this study. The selection of the particular age group used in the present study was influenced by theories which suggest that external verbal instructions are especially effective at this particular age level. There is still a good deal of doubt about the truth of this hypothesis, and developmental studies of shift

learning with the improved paradigm should help to illuminate the issue.

The question of how verbalization affects mediation would be more satisfactorily answered by the inclusion of a verbalization group which is required to verbalize only the relevant dimension, and a verbalization group which is required to verbalize both dimensions. If verbalization is effective only in building or strengthening mediational chains to a verbalized dimension an intradimensional shift should be facilitated and an extradimensional shift hampered when only the relevant dimension is verbalized during training. If, however, verbalization has the general effect of encouraging subjects to mediate, then both intradimensional and extradimensional shifts should be speeded up whether relevant only or relevant and irrelevant dimensions are verbalized.

Educational. Considering the theoretical issues at stake the current inquiry could not be expected to offer much in the way of immediate practical implications. However, the manner in which attentional responses are learned is a general issue which must, in the final analysis, be of fundamental importance in the classroom. Perhaps one of the most important tasks that must be achieved by the child through the early years of school is to learn to "pay attention". In order to learn an association the child must learn to attend to the

appropriate part of the stimulus field. According to Mostofsky (1968) the amount and quality of learning depends on the amount and quality of attention. The growth of what Luria calls "voluntary attention" during development is a crucial component in the degree to which the child can achieve satisfaction and success in the classroom. The present study reaffirms the importance of language in training the child to achieve self-regulatory attention and suggests that deficits in attention among "slow-learners" or culturally-deprived children may be influenced to a considerable degree by the impoverished verbal environment to which these children have been exposed. Finally the study highlights the importance of seeing different kinds of behavior, such as verbal and perceptual processes, often conceived of as entirely distinctive processes, as intricately interwoven in the ongoing development of the child.

It is to be hoped that after some of the theoretical issues about mediation have been thrashed out the efforts of researchers will be directed more towards applying some of their findings to the field of education, just as operant conditioning theory has been applied through behavior modification practices. The behavior modifiers have made rapid progress in the modification of overt classroom-relevant behavior. In the future one may expect that mediation theory will open the way towards modifying more

covert behavior such as the growth of concepts, behavior which is of perhaps even greater educational significance than the behavior which is commonly submitted to external control.

Summary

The purpose of the present study was to examine the learning rates and tactual observing responses of children during tasks involving positive transfer of mediation (an intradimensional shift), absence of mediational transfer (a control shift) and negative transfer of mediation (an extradimensional shift) in order to determine whether the mediation involved was attentional in nature. Also the study examined the effect of verbalizing labels for stimulus cues on speed of learning and tactual observing responses.

The literature in the area of mediational problem-solving tended to divide into two streams of authors--those who argue that mediation transfer involves the learning and transfer of verbal or symbolic cues (Kendler, 1970) and those who favour the view that mediational transfer is primarily attentional in nature (Zeaman & House, 1963). Luria's (1969) argument that verbal labels actually have the effect of directing selective attention, was found to be a useful amalgamator of the two streams of thought. An examination of experimental studies in shift learning tended to lend support to the attentional view, but mainly

because findings which had previously been regarded as supportive of the verbal mediational hypothesis had been sharply criticized for methodological deficiencies. In fact the role of verbal mediation in mediational problem-solving had never been tested, to the present writer's knowledge, with the improved shift paradigm. Moreover, the view that both attentional and verbal mediation might be involved and interdependent in discrimination shift learning seemed to have been given very little consideration.

One hundred and eight grade one children were randomly assigned to one of three shift groups (intra-dimensional, extradimensional and control shifts) and one of three verbalization groups (spontaneous, assigned and no verbalization). In the spontaneous verbalization treatment, subjects were directed to overtly verbalize their own labels for irrelevant and relevant stimulus cues, while in the assigned verbalization group the experimenter provided appropriate verbal labels for the relevant and irrelevant cues. All subjects were given a tactual discrimination problem with one dimension relevant and one dimension irrelevant. In an extradimensional shift, subjects were required to learn to respond on shift to a previously irrelevant dimension; in an intradimensional shift, subjects were shifted to a problem where the same dimension remained relevant; and in a control shift subjects were shifted to a problem containing entirely new

dimensions. The _trials to criterion_, _relevant_ and _total observing per trial_, the _percentage relevant observing per trial_ and the _couplings per trial_ of the different experimental groups were compared.

The results indicated that an intradimensional shift was learned most rapidly, a control shift at an intermediate rate and an extradimensional shift most slowly. During the trials immediately after the shift, subjects in an intradimensional shift tended to observe the relevant dimension more than the irrelevant dimensions, subjects in an extradimensional shift observed the irrelevant dimension more than the relevant dimension, while subjects in a control shift observed both dimensions about equally. Verbalization had the effect of increasing the overall tendency of subjects to observe both the relevant and irrelevant dimensions during pre- and post-shift tasks. Verbalization did not have a main effect on speed of learning the training task but it actually slowed down the performance of girls. On the shift task, however, verbalization facilitated solution regardless of the type of shift being performed. Finally, subjects who were able to correctly verbalize the solutions to the discrimination problems tended to learn the shift problem faster,and observe the relevant dimension more in the trials immediately following the shift. Verbalization treatment was found to increase the likelihood that subjects would be able to

correctly verbalize problem-solution.

The findings of the study provided support for arguments that mediational transfer in discrimination learning involves the transfer of attentional responses. The study also suggested, however, that attentional mediation may be influenced by verbal directions and possibly be accompanied by verbal mediation in mediational problem-solving. Whether verbalization treatments had the effect of enhancing direct transfer by strengthening mediational chains relevant to shift solution, or whether it had the effect of increasing indirect transfer by encouraging the tendency to mediate during both training and shift tasks, or whether both of these events occur is not clear from the present findings. However, the observing response data tends to suggest that verbalization enhances indirect transfer since it facilitates observing responses to both relevant and irrelevant cues after a control shift. In order to illuminate the nature of the effect of verbalization on mediational problem-solving, the writer suggests a design in which one verbalization group is required to verbalize only the relevant dimension. It was deemed necessary to extend the generality of the present findings by looking at discrimination in other modalities and other measures of selective attention in future research.

R E F E R E N C E S

REFERENCES

Anastasi, A. Differential psychology. (3rd ed.) New York: Macmillan, 1958.

Berlyne, D. E. Conflict, arousal and curiosity. New York: McGraw-Hill, 1960.

Berlyne, D. E. The development of the concept of attention in psychology. Unpublished paper read at Middlesex conference, 1967.

Berlyne, D. E. Attention as a problem in behavior theory. In D. Mostofsky (Ed.) Attention: contemporary theory and analysis. New York: Appleton-Century-Crofts, 1971.

Blank, M. & Altman, L. D. The effect of stimulus modality and task complexity on discrimination and reversal learning in pre-school children. Journal of Experimental Child Psychology. 1968, 6, 598-606.

Blum, A. & Adcock, C. Attention and early learning: a selected review. Journal of Education. 1968, 50, 29-40.

Brown, Z. & Smith, J. Tactual-kinesthetic discrimination shifts in retarded children. Journal of Experimental Child Psychology. 1967, 5, 455-462.

Buss, A. H. Rigidity as a function of reversal and non-reversal shifts in the learning of successive discriminations. Journal of Experimental Psychology. 1953, 45, 75-81.

Carmichael, L. (Ed.) Manual of Child Psychology. 2nd ed. New York: Wiley, 1954.

Cole, M. & Maltzmann, L. (Eds.) A Handbook of contemporary soviet psychology. New York: Basic Books, 1969.

Dickerson, D. J. Irrelevant stimulus discrimination and dimensional transfer in the discrimination learning of children. Journal of Experimental Child Psychology. 1967, 5, 228-236.

Dickerson, D. J. Effects of naming relevant and irrelevant stimuli on the discrimination learning of children. Child Development. 1970, 41, 639-650.

Eimas, P. D. Effects of overtraining and age on intra-dimensional and extradimensional shifts in children. Journal of Experimental Child Psychology. 1966, 348-355.

Ellis, N. R. (Ed.) International review of research in mental retardation. Vol. 2. New York: Academic Press, 1966.

Fellows, B. J. The discrimination process and development. Oxford: Pergamon Press, 1968.

Gollin, E. S. & Saravo, A. A developmental analysis of learning. Unpublished material to appear in Cognitive Studies, Volume 1. Hellmuth, J. (Ed.), 1969.

Goss, A. E. Verbal mediating responses and concept formation. Psychological Review. 1961, 68, 248-274.

Hebb, D. O. A textbook of psychology. (2nd ed.) Philadelphia: Saunders, 1966.

House, B. & Zeaman, D. Reversal and non-reversal shifts in discrimination learning in retardates. Journal of Experimental Psychology. 1962, 63, 444-451.

Jensen, A. R. Verbal mediation and educational potential. Psychology in the Schools. 1966, 3, 99-109.

Johnson, P. J. & White, R. M. The concept of dimensionality and reversal shift performance in children. Journal of Experimental Child Psychology. 1967, 5, 223-227.

Kelleher, R. T. Discrimination learning as a function of reversal and non-reversal shifts. Journal of Experimental Psychology. 1956, 51, 379-384.

Kendler, H. H. & D'Amato, M. F. A comparison of reversal and non-reversal shifts in human concept formation behavior. Journal of Experimental Psychology. 1955, 49, 165-174.

Kendler, H. H. & Kendler, T. S. Vertical and horizontal processes in problem solving. Psychological Review. 1962, 69, 1-16.

Kendler, H. H. & Kendler, T. S. Selective attention versus mediation. Psychological Bulletin. 1966, 66 (4), 282-288.

Kendler, H. H. & Kendler, T. S. Mediation and conceptual behavior. In Spence, K. & Spence, J. (Eds.) The Psychology of learning and motivation. Vol. 2. New York: Academic Press, 1968, Pp. 197-224.

Kendler, T. S. Development of mediating responses in children. In Wright, J. C. & Kagan, J. Basic cognitive processes in children. Monographs of the Society for Research in Child Development. 1963, 28 (2, Whole No. 86), Pp. 33-52.

Kendler, T. S. & Kendler, H. H. Reversal and non-reversal shifts in kindergarten children. Journal of Experimental Psychology. 1959, 58, 56-60.

Kendler, T. S. & Kendler, H. H. Optional shifts of children as a function of number of trials on the initial discrimination. Journal of Experimental Child Psychology. 1966, 3, 216-224.

Kendler, T. S. & Kendler, H. H. An ontogeny of optional shift behavior. Child Development. 1970, 41, 1-27.

Kendler, T. S., Kendler, H. H., & Learnard, B. Mediated responses to size and brightness as a function of age. American Journal of Psychology. 1962, 75, 571-586.

Knowles, D. W. & Boersma, F. J. Optional shift performance of culturally-different children to concrete and abstract stimuli. Alberta Journal of Educational Research. 1968, 14, 165-177.

Kuenne, M. R. Experimental investigation of the relation of language to transposition behavior in young children. Journal of Experimental Psychology. 1946, 36, 471-490.

Lipsitt, L. P. & Spiker, C. C. Advances in child development and behavior. Vol. 2. New York: Academic Press, 1965.

Lovejoy, E. Analysis of the overlearning reversal effect. Psychological Review. 1966, 73, 87-103.

Luria, A. R. The role of speech in the regulation of normal and abnormal behavior. New York: Liveright, 1961.

Luria, A. R. Speech development and the formation of mental processes. In M. Cole & I. Maltzman (Eds.) A handbook of contemporary Soviet psychology. New York: Basic Books, 1969, Pp. 121-162.

Mackintosh, N. J. Selective attention in animal discrimination learning. Psychological Bulletin. 1965, 64, 124-150.

Mandler, G. From associations to structure. Psychological Review. 1962, 69, 415-427.

Miller, S. A., Shelton, J., & Flavell, J. H. A test of Luria's hypotheses concerning the development of verbal self-regulation. Child Development. 1970, 41, 651-665.

Morris, L. A. & Tempone, V. J. Relational responding by elementary school children to a transposition task. Child Development. 1969, 40, 1203-1212.

Mostofsky, D. I. Attentional research: The case of the verbal phantom. Journal of Education. 1968, 150, 4-19.

Mostofsky, D. I. Attention: Contemporary theory and analysis. New York: Appleton-Century-Crofts, 1971.

Reese, H. W. & Lipsitt, L. P. Experimental Child Psychology. New York: Academic Press, 1970.

Reynolds, G. S. A primer of operant conditioning. Glenview, Ill.: Scott, Foresman, 1968.

Rydberg, S. Concept learning: measured selective attending changes. Psychonomic Science. 1969, 16, 293-295.

Rydberg, S. & Arnberg, P. W. Overlearning, extinction, and superstition effects on observing behavior in concept learning. Psychonomic Science. 1969, 17, 343-344 (a).

Rydberg, S. & Arnberg, P. W. Selective attending changes during concept learning, extinction, and superstition. Psychonomic Science. 1969, 17, 99-100 (b).

Rydberg, S., Kashdan, R. & Trabasso, T. Recording or tactile observing responses for the study of selective attention. Psychonomic Science. 1966, 6, 197-198.

Shepp, B. E. & Eimas, P. D. Intradimensional and extra-dimensional shift in the rat. Journal of Comparative and Physiological Psychology. 1964, 57, 357-361.

Shepp, B. E. & Schrier, A. M. Consecutive intradimensional and extradimensional shifts in monkeys. Journal of Comparative and Physiological Psychology. 1969, 67, 199-203.

Shepp, B. E. & Turrisi, F. D. Learning and transfer of mediating responses in discriminative learning. In N. R. Ellis (Ed.) International review of research in mental retardation. Vol. 2. New York: Academic Press, 1966. Pp. 86-120.

Shepp, B. E. & Turrisi, F. D. Effects of overtraining on the acquisition of intradimensional and extradimensional shifts. Journal of Experimental Psychology. 1969, 82, 46-51.

Shepp, B. E. & Zeaman, D. Discrimination learning of size and brightness by retardates. Journal of comparative and physiological psychology. 1966, 62, 55-59.

Silverman, I. W. Effect of verbalization on reversal shifts in children: Additional data. Journal of Experimental Child Psychology. 1966, 4, 1-8.

Silverman, I. W. & Craig, J. G. Mediational performance as affected by overt verbalization during training and testing. Child Development. 1969, 40, 295-305.

Slamecka, N. J. A. A methodological analysis of shift paradigms in human discrimination learning. Psychological Bulletin. 1968, 69, 423-438.

Spence, K. & Spence, J. The psychology of learning and motivation. Vol. 2. New York: Academic Press, 1968.

Staats, A. W. & Staats, C. K. Complex human behavior: a systematic extension of learning principles. New York: Holt, Rinehart & Winston, 1963.

Sutherland, N. S. Stimulus analyzing mechanisms. In Proceedings of a symposium on the mechanization of thought processes. Vol. 2. London: H. M. Stationery Office, 1959. Pp. 575-609.

Terman, L. M. & Tyler, L. E. Psychological sex differences. In L. Carmichael (Ed.) Manual of child psychology. (2nd ed.) New York: Wiley, 1954.

Trabasso, T., Deutsch, J. A., and Gelman, R. Attention in discrimination learning of young children. Journal of Experimental Child Psychology. 1966, 4, 9-19.

Tyler, L. E. The psychology of human differences. New York: Appleton-Century-Crofts, 1965.

Vurpillot, E. The development of scanning strategies and their relationship to visual differentiation. Journal of Experimental Child Psychology. 1968, 6, 632-650.

Vygotsky, L. S. Thought and language. Cambridge, Mass.: M.I.T. Press, 1962.

Weir, M. W. & Stevenson, H. W. The effect of verbalization in children's learning as a function of chronological age. Child Development. 1959, 30, 143-149.

White, R. M. & Johnson, P. J. Concept of dimensionality and optional shift performance in nursery school children. Journal of Experimental Child Psychology. 1968, 6, 113-119.

White, S. H. Evidence for a hierarchical arrangement of learning processes. In L. P. Lipsitt & C. C. Spiker (Eds.) Advances in child development and behavior. Vol. 2. New York: Academic Press, 1965. Pp. 187-220.

White, S. H. & Plum, G. E. Eye movement photography during children's discrimination learning. Journal of Experimental Child Psychology. 1964, 1, 327-338.

Winer, B. J. Statistical principles in experimental design. New York: McGraw-Hill, 1962.

Wolff, J. L. Concept-shift and discrimination-reversal learning in humans. Psychological Bulletin. 1967, 68, 369-408 (a).

Wolff, J. L. Effects of verbalization and pretraining on concept attainment by children in two mediation categories. Journal of Educational Psychology. 1967, 58, 19-26 (b).

Wright, J. C. & Kagan, J. Basic cognitive processes in children. Monographs of the Society for Research in Child Development. 1963, 28 (2, Whole No. 86), Pp. 33-52.

Wyckoff, L. B. The role of observing responses in discrimination learning. Psychological Review. 1952, 59, 431-442.

Zeaman, D. & House, B. J. The role of attention in retardate discrimination learning. In N. R. Ellis (Ed.) Handbook of mental deficiency. New York: McGraw-Hill, 1963, Pp. 159-223.

A P P E N D I X A

Task Instructions Given to Subjects

TASK INSTRUCTIONS GIVEN TO SUBJECTS

Pre-Training Task

The following instructions were given at the beginning of the pre-training task, when the first stimulus pair was visible in the windows of the apparatus.

> "Now we are going to play a game where there are two things and one of them is always the winner. You see there's a picture on this side and a picture on that side. Let's see if you can guess the winner." (Child makes choice.) "Good, that's fine." (Second stimulus pair presented.) "Now, which one do you think is the winner? Good, that's the winner because the winner always has the dots on the top/bottom and it doesn't matter what color the circle is./ No, that's the loser because the winner always has the dots on the top/bottom and it doesn't matter what color the circle is. Let's try a few more for practice, shall we?"

Discrimination Learning Task

The following instructions were given to children before presenting them with the tactual discrimination. The subject was taken around to the experiment's side of the apparatus while the first part of the instructions were being given.

"Well we're going to do something a bit like that only this time you're not allowed to look--you feel. It's a feeling game. Look in the box. Now there will be a thing on this side" (experimenter points to space where stimuli go) "and a thing on this side and one of them is the winner. You can tell which one's the winner if you feel the things very carefully, and the winner always has a bean in the hole under it.

Now you go round and sit on that side and put your hand through the hole. Leave your hand there for a minute and when I tell you 'Ready', I want you to feel."

Trial 1. "Ready. Now feel very carefully. There's a thing on this side and a thing on this side" (experimenter guides subject's hand onto the stimuli). "Remember, there's always one thing about the winner that's the same. Take as long as you like and then push the one you think is the winner and see if there's a bean in the hole under it. Now feel it all. Right, that was the winner, put the bean into my hand and I'll pass it to you. You can change the beans you win for a prize at the end./ No, that was the loser."

Trial 2. "Ready. Now remember there's always one thing about the winner that's the same."

After the second trial no other verbal instructions were given (for subjects in the no verbalization group) except that on every tenth trial the experimenter said: "Remember there's always one thing about the winner that stays the same."

Verbalization Groups

The following verbal instructions were administered to subjects in the verbalization groups during trial one after the experimenter said "Now feel it all" and before the subject was permitted to make a response. The same instructions were also administered during the second trial.

Spontaneous Verbalization. "Tell me what the things feel like." If subjects only verbalized labels to one dimension, the experimenter asked: "How else are the things different?"

Assigned Verbalization. (Extradimensional and intradimensional shifts). "This thing is a square with a furry top and this thing is a circle with a smooth top. Now you tell me what they are." (Subject then repeats labels and is verbally rewarded with "Good" or "Yes"). For the next trial: "This thing is a circle with a furry top and this thing is a square with a smooth top. Now you tell me what they are." The subject then repeats the labels and is verbally rewarded with

"Good" or "Yes".

(Control shift). "This thing is big with one bump on top and this thing is little with three bumps on top." and "This thing is little with one bump on top and this thing is big with three bumps on top." (The intervening instructions, except for the actual labels were the same for the control shift as for the intradimensional shift).

Solution Verbalization

At the end of the shift task, when the subject had reached criterion and had withdrawn his hand from the apparatus, he was asked the following question:

"Can you tell me which one was the winner?" When the subject had produced some kind of response to this question, the experimenter asked: "Do you remember which one was the winner the first time when we had squares and circles and smooth ones and furry ones/big ones and small ones and one bump and three bumps?"

APPENDIX B

Portion of Gellerman Series Used in Discrimination Learning Tasks

GELLERMAN SERIES

Abbreviations: (Furry Circle = FC
(
(Smooth Square = SS

(Furry Square = FS
(
(Smooth Circle = SC

Trials	Left	Right
1	FC	SS
2	SC	FS
3	FS	SC
4	FC	SS
5	SS	FC
6	FS	SC
7	SC	FS
8	FC	SS
9	SS	FC
10	FS	SC
11	SC	FS
12	SS	FC
13	FC	SS
14	FS	SC
15	SS	FC
16	SC	FS

APPENDIX C

Reliability Indices for Inter-Scorer and Intra-Scorer Reliability

TABLE 2

INTER-SCORER RELIABILITY - PERCENTAGE AGREEMENTS

	Number of Relevant Observing R's			Number of Total Observing R's			Number of Couplings		
Pre-Shift	1st 10	Crit.	Tot.	1st 10	Crit.	Tot.	1st 10	Crit.	Tot.
Subjects									
1	87.3	75.9	81.1	90.0	94.3	91.2	94.5	100.0	98.6
2	90.6	95.6	96.3	83.6	88.5	93.5	95.0	100.0	98.4
3	100.0	94.8	95.7	94.5	97.4	95.7	100.0	100.0	100.0
4	94.2	96.5	92.1	91.4	92.8	90.4	100.0	100.0	100.0
Post-shifts									
1	83.7	90.4	96.2	97.2	86.0	94.2	100.0	100.0	100.0
2	84.7	100.0	91.5	97.7	100.0	97.3	100.0	100.0	100.0
3	97.7	100.0	99.3	89.7	94.9	95.0	100.0	100.0	100.0
4	79.0	79.8	79.8	90.7	90.7	90.7	100.0	100.0	100.0
Means			91.5			93.5			99.6

TABLE 3

INTRA-SCORER RELIABILITY - PERCENTAGE AGREEMENTS

Pre-shift	Number of Relevant Observing R's			Number of Total Observing R's			Number of Couplings		
	1st 10	Crit.	Tot.	1st 10	Crit.	Tot.	1st 10	Crit.	Tot.
Subjects									
1	93.5	100.0	98.2	94.0	97.8	99.6	100.0	100.0	100.0
2	86.7	85.0	89.7	91.2	85.8	91.7	100.0	100.0	100.0
3	85.8	90.5	89.5	91.1	87.6	89.6	100.0	100.0	100.0
4	93.2	93.8	99.0	95.9	95.4	97.7	100.0	100.0	100.0
5	85.7	92.8	93.5	89.7	100.0	98.4	100.0	100.0	100.0
Post-shifts									
1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2	87.4	87.4	87.4	87.8	87.8	87.8	100.0	100.0	100.0
3	83.4	91.3	96.6	84.0	87.9	91.0	100.0	100.0	100.0
4	100.0	100.0	100.0	95.2	95.2	95.2	100.0	100.0	100.0
5	100.0	100.0	90.9	100.0	100.0	95.2	100.0	100.0	100.0
Means			94.5			94.6			100.0